REPORT
CANADIAN PACIFIC RAILWAY
1877.

SANDFORD FLEMING,

ENGINEER-IN-CHIEF

REPORT

ON

SURVEYS

AND

PRELIMINARY OPERATIONS

ON THE

CANADIAN PACIFIC RAILWAY

UP TO JANUARY 1877.

BY

SANDFORD FLEMING,
Engineer in Chief.

OTTAWA:
PRINTED BY MacLEAN, ROGER & CO., WELLINGTON STREET.
1877.

To His Excellency the Right Honourable Sir FREDERIC TEMPLE, *Earl of* DUFFERIN, *K.P., G.C.M.G., K.C.B., Governor General of Canada, &c., &c., &c.*

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to present to Your Excellency the Report of the Engineer in Chief on the Surveys and preliminary operations made in connection with the Canadian Pacific Railway, up to the end of the year 1876.

A. MACKENZIE,

Minister of Public Works.

CANADIAN PACIFIC RAILWAY,

OFFICE OF THE ENGINEER IN CHIEF,

SIR,—I have the honour to transmit, for the information of His Excellency the Governor General in Council, the accompanying Report, relating to the Surveys and preliminary operations in connection with the Canadian Pacific Railway.

I have the honour to be, Sir,

Your obedient servant,

SANDFORD FLEMING,

Engineer in Chief.

To The Hon. ALEXANDER MACKENZIE,

Premier and Minister of Public Works,

Canada.

TABLE OF CONTENTS.

APPENDICES.

MAPS.


134
133
132
131
130
55
54
53
52
51
50
49
48
ALASKA
Portland Channel
DIXON ENTRANCE
PORTLAND INLET
BROWN PASSAGE
North Pt.
Masset Spit
Masset Har.
C. Fife
GRAHAM Pt.
SKIDEGATE INLET
QUEEN CHARLOTTE ISLANDS
Principe Ch.
MORESBY Pt.
Tasso Har.
NEPEAN Sd.
Estevan I.
Aristizable I.
PREVOST Id.
C. St. James
Price I.
MILBANK SOUND
C. Swain
NORTH PACIFIC OCEAN
QUEEN CHARLOTTE Sd.
FITZHUGH Sd.
Triangle Id.
SCOTT Is.
C. Scott
C. Russell
C. Palmerston
Ft. Rupert
QUATSINO Sd.
Brooks Bay
Cape Cook
KYUQUOT Sd.
ESPERANZA INLET
NOOTKA Sd.
Drawn for Photo-lithography by
J. JOHNSTON, C.D., Domn. Lands Office.
Scale of Statute Miles
131
130
129
128
127


MAP
OF THE COUNTRY TO BE TRAVERSED BY THE
CANADIAN PACIFIC RAILWAY
TO ACCOMPANY PROGRESS REPORT ON THE EXPLORATORY SURVEYS
1877.
Sandford Fleming, Engineer-in-Chief
EXPLANATIONS
LAKE SUPERIOR
DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
LAKE HURON
LAKE ONTARIO
JAMES BAY

SURVEY

AND

PRELIMINARY OPERATIONS

CANADIAN PACIFIC RAILWAY.

———o———

REPORT

BY

SANDFORD FLEMING,

Engineer in Chief,

ADDRESSED TO

THE HON. ALEXANDER MACKENZIE,

Minister of Public Works, Canada

———o———

Office of the Engineer in Chief,

Ottawa, Feby. 8th, 1877.

Sir,—I have the honour to submit the following Report on the Surveys and Explorations carried on under my directions to determine the location of the Canadian Pacific Railway.

Commenced in 1871, these Surveys have extended over a period of six years; and it now becomes my duty to place before you the results arrived at, so that, as far as practicable, the information deducible from the several examinations may be made accessible for reference, and the facts which have been established by these six years of labour may fully and properly be preserved.

It is hoped that the Report will clearly and concisely describe the work carried on year by year, and explain the progressive results obtained, so that they may be easily comprehended. The repeated failures which have been experienced will be alluded to, in order to account for the necessity of the frequently renewed efforts to obtain the ends desired.

The Surveys stretch from the valley of the Ottawa, west of the Capital, to that portion of the Pacific Coast lying between Alaska on the north and the Straits of Juan de Fuca on the south. Consequently, they embrace a field of enquiry extending over fifty-four degrees of longitude, limited by ten degrees of latitude.

In this effort to place before you an outline of the progress and general results of the Survey, much of the detail must, necessarily, be omitted

(The main division of the Territory.)

In previous Reports, the three regions into which nature has divided the territory to be traversed by the railway, were designated *The Woodland, The Prairie* and *The Mountain* Regions.

These three divisions of territory and the designations affixed to them will be here retained. The physical outlines of each division were fully explained, and the special characteristics which call for consideration in each, were sufficiently described in a former report.*

Their general characteristics are strongly marked. First, *The Woodland* Region, to the east, is densely wooded. Second, *The Mountain* Region, to the west, is wooded and mountainous. The third is a vast lowland country, interspersed with, or border ing on extensive prairies.

Before the survey was entered upon, the *Central* or *Prairie* Region had been traversed repeatedly by scientific explorers, and its character was generally understood; but much of the *Mountain* and *Woodland* Regions was unvisited and unknown. To a great extent, both were held to be rugged and in some degree impenetrable.

---

* *Vide* Report, 26th January, 1874.

(The Expenditure.)

The expenditure on the Survey during the six years it has been carried on has been as follows:—

In 1871 and up to June 1872	$489,428	16
From June 1872 to June 1873	561,818	44
,, 1873 ,, 1874	310,224	88
,, 1874 ,, 1875	474,529	89
, 1875 ,, 1876	791,121	19
,, 1876 to December 1876	509,493	19
Total	$3,136,615	75

(Character of the Examinations.)

The examinations made have not all been of the same character. Dictated by circumstances, they have varied as expediency suggested. They may be classified thus:—

1. Explorations.
2. Exploratory Surveys.
3. Revised Surveys.
4. Trial Locations.
5. Location Surveys.
6. Revised Locations.

These examinations may be thus defined:—

Explorations.—Preliminary examinations in advance of regular surveys, the barometer being used for ascertaining altitudes; horizontal distances being computed from the time occupied in passing from place to place. In some cases distances were measured by the micrometer.

Exploratory Surveys. -An instrumental survey; the chain, transit, theodolite or compass, and spirit level, being the instruments used. In densely wooded localities, it may consist of a series of straight lines, connected by angles, cut through the forests and thickets, in order to pierce them and obtain measurements, horizontal and vertical, as a ground work for further operations.

Revised Survey.—A survey, such as last described, through broken ground or dense woods, revised, so as to avoid the difficulties which may have presented themselves in the first place, and, if practicable, to shorten distance. This proceeding is frequently indispensable, in order to gain more assured knowledge of the ground in districts wild and unknown, and to prepare the way for location.

Trial Location Survey.—The first attempt at staking out the line for construction; the tangents being laid down, and, when necessary, the curves being set out.

Location Survey.—It rarely happens that the first location survey, except in level tracts, is in every respect satisfactory. When heavy work or objectionable gradients are met, or the line appears unnecessarily lengthened, a re-survey of those portions of the line is called for. The location must be considered incomplete, until every effort has been made to throw out all objectionable features by revising the survey; such revision is designated the "Location Survey." In broken, hilly country, even further examinations and changes may be called for, in which case the term Revised Location Survey, may be employed.

The following is an outline of the principal examinations which have been made in each year:—

Explorations and Surveys in 1871.

In the Mountain Region.

1. Exploration along the whole extent of the River North Thompson, from Kamloops to Lake Albreda, thence to Lake Yellow Head the source of the Fraser, *via* Lake Cranberry and Tête Jaune Cache.

2. Exploration from Quesnelle mouth and Barkerville in the Cariboo District, towards Tête Jaune Cache.

3. Exploratory Survey from Kamloops along the River South Thompson to Lake Shuswap.

4. Exploratory Survey from the River Blaeberry to Howse Pass and Kootenay Plain.

5. Exploration along the River Columbia from its source, near the 50th parallel to Boat Encampment, near the Athabasca Pass.

6. Exploration from Lake Shuswap, through the Eagle Pass, to the River Columbia and thence north to Boat Encampment.

7. Exploratory Survey from Kamloops along the River Thompson, to Lytton and thence by the lower Fraser to its navigable waters at Yale and Fort Hope.

In the Prairie Region.

8. Exploration from Fort Garry westward to Rocky Mountain House and Howse Pass, with branch exploration to Jasper House, Lac la Biche and Swan River.

In the Woodland Region.

9. Exploratory Survey from Mattawa, east of Lake Nipissing, to the confluence of the Rivers Montreal and Ottawa.

10. Exploratory Survey from the River Ottawa to a point near the head of the River Montreal.

11. Exploratory Survey from the great northern bend of the River Montreal to a point about half way to Moose River.

12. Exploratory Survey from the west branch of Moose River, eastward to the point last mentioned.

13. Exploratory Survey from Moose River to Small Black River, inland from the north shore of Lake Superior.

14. Exploratory Survey from Small Black River to Long Lake.

15. Exploratory Survey from Long Lake to the mouth of the River Nepigon.

16. Exploratory Survey from the mouth of the River Nepigon to Lac des Isles.

17. Exploratory Survey from Lac des Isles to the canoe route to Lac Seul.

18. Exploratory survey from the canoe route, to Whitefish Bay on the Lake of the Woods.

19. Exploratory survey from Whitefish Bay to Red River in Manitoba.

20. Exploration northward by the Rivers Ottawa and Abittibi, to James Bay returning by the Rivers Moose and Michipicoten to Lake Superior.

21. Exploratory Survey from Sault Ste. Marie along the north shore of Lake Huron to French River;

Explorations and Surveys in 1872.

In the Mountain Region.

1. Exploration across the whole breadth of the Rocky Mountain Zone, passing from the Jasper Valley by the Yellow Head Pass and Thompson Valley to the coast.

2. Explorations in the approaches to the Howse Pass, the Athabasca Pass, and the Yellow Head Pass.

3. Explorations in the Cariboo District, from Lake William to the forks of the River Quesnelle, thence up the south branch of the same, and along the south shore of Lake Quesnelle to near its head.

4. Exploration from Lake William to the mouth of the River Horse-fly, and up that river 30 miles; thence across to Lakes Canim and Mahood, and by the River Clearwater to its junction with the North Thompson.

5. Exploratory Survey from Jasper Valley through Yellow Head Pass, along the north bank of the River Fraser to Tête Jaune Cache.

6. Exploratory Survey from Tête Jaune Cache, across by Lakes Cranberry and Albreda to the River North Thompson.

7. Exploratory Survey down the whole length of the River Thompson to Kamloops.

8. Exploratory Survey from the confluence of the Rivers Clearwater and Thompson, westward to the River Fraser near Lake Williams.

9. Exploratory Survey from Waddington Harbour, by the River Homathco, to the Chilicotin Plain, thence to the River Fraser.

10. Exploratory Survey from Waddington Harbour to Seymour Narrows.

11. Exploratory Survey from Fort Hope, on the Lower Fraser, by the Coquihalla Valley, to the summit of Coquihalla Pass.

12. Exploration from the summit of Coquihalla Pass, to Lake Nicola.

13. Exploratory Survey from Lake Nicola to Kamloops.

14. Exploration between the Rivers Peace and Skeena, and part of the country north of the 54th parallel.

In the Prairie Region.

15. An exploring expedition traversed the country from the Lake of the Woods in the East, to the mountains in the West,

In the Woodland Region.

16. Exploration from Lake of the Woods, directly east to Lake Nepigon and Nepigon Bay, Lake Superior.

17. Continuation of the Exploratory Survey from the River Mattawa to the confluence of the Rivers Montreal and Ottawa.

18. Continuation of the Exploratory Survey from the River Ottawa to the Great Bend of the River Montreal.

19. Exploration from the River Nepigon to the north end of Long Lake.

20. Exploratory Survey from the north end of Long Lake to a point in the previous year's Survey, about 65 miles north of Michipicoten.

21 Exploratory Survey from the north end of Long Lake to the north side of Lake Nepigon.

22. Exploratory Survey from the north side of Lake Nepigon, westward to Sturgeon Lake.

23. Exploratory Survey between Lakes Sturgeon and Eagle.

24. Exploratory Survey of branch line from Nepigon Bay northward.

25. Exploratory Survey of branch line from Thunder Bay northward.

Explorations and Surveys in 1873

In the Mountain Region.

1. Exploratory Survey from Moose Lake, westward along the River Fraser, (south bank.)

2. Exploration from Lac la Hache to River Horse-fly, and thence towards Lake Clearwater.

3. Exploratory Survey from Howe Sound, *via* Rivers Tsee-ark-Amisht, Green, Sealux, Fraser and Bonaparte, to the River Thompson, below the confluence of the River Clearwater.

In the Prairie Region.

4. Exploration along the River Saskatchewan from Lake Winnipeg to Rocky Mountain House

5. Survey of portages (1) between Cedar Lake and Lake Winnepegoosis. (2.) Between Lakes Winnepegoosis and Manitoba. (3.) Between Lake Manitoba and the River Assiniboine; also, survey of Water Hen River, Partridge Creek and River Dauphin.

In the Woodland Region.

6. Exploration from Lake Nipissing, in a north-westerly direction, to Ma-tag-a-ma, Moose River.

7. Exploratory Survey from north end of Long Lake *viâ* south-east angle of Lake Nepigon to the River Nepigon.

8. Survey of Lake Helen, River Nepigon, and Nepigon Harbour.

9. Survey of the navigable portion of the River Kaministiquia.

10. Exploratory Survey from the River Nepigon to Black Sturgeon Lake.

11. Exploratory Survey from Black Sturgeon Lake to Chiefs Bay, Lake Nepigon.

12. Exploratory Survey from Chiefs Bay to Gull River.

13. Exploratory Survey from White Fish Lake to Sturgeon Lake.

14. Exploratory Survey from White Fish Lake to Sandy Lake.

Explorations and Surveys in 1874.

In the Mountain Region.

1. Exploration from River Clearwater to the North Thompson, *viâ* Blue River.

2. Exploration from Lake Clearwater towards Tête Jaune Cache.

3. Re-examination of the route by Coquihalla Pass.

4. Exploration across the Cascades by the Similkameen Valley, and also by the River Tulameen.

5. Exploratory Survey from Fort Hope, along the River Fraser to Burrard Inlet.

6. Revised Survey on a section of the Canyons of the Fraser above Yale.

7. A re-survey of part of Route No. 4, Thompson Valley to Bute Inlet.

8. Exploratory Survey from Tête Jaune Cache to Fort George, thence by the Chilacoh, Blackwater and Chilicotin Valleys to Lake Tatla.

9. Exploration along the coast of British Columbia, north of Vancouver Island

10. Exploration inland from Dean and Gardner Channels.

11. Exploration up the River Blackwater to its source and across the divide to the Salmon River; thence along the eastern flank of the Cascade Mountains northward by a chain of lakes and crossing the tributaries of the River Nechaco to Lake François.

12. Exploration around Lake François.

13. Exploration from Lake François by the River Stilacoh to Lake Fraser, thence by the Rivers Nechaco and Stewart to Fort George.

In the Prairie Region.

14. Survey of the Narrows of Lake Manitoba and portions of the River Saskatchewan.

15. Survey for projected canal between Lakes Winnepegoosis and Manitoba.

16. Exploratory Survey from Selkirk (Red River) to the Narrows of Lake Manitoba, thence by Mossy River and Swan River to Livingstone.

17. Examination and borings respecting water and mineral fuel.

18. Commencement of the location Survey east of Livingstone.

In the Woodland Region.

19. Location Survey of the Pembina Branch.

20. Exploration from French River on Georgian Bay to the River Ottawa.

21. Exploration from Parry Sound *via* Carleton Place to the city of Ottawa.

22. Harbour survey at the mouth of French River.

23. Exploration from Lake Superior at River Pic, eastward to Lake Missanabe.

24. Survey of Portages on the Dawson route, between Lakes Shebandowan and Lake of the Woods.

25. Exploratory Survey from Thunder Bay to Lake Shebandowan.

26. Trial Location Survey from Keewatin (Rat Portage) eastward to Lake Vermillion.

27. Exploration eastward from Lake Wabigoon to English River.

28. Trial Location Survey from Selkirk (Red River,) eastward to Keewatin (Rat Portage).

29. Exploratory Survey from River Nepigon, along the Coast of Lake Superior to River Pic.

30. Trial Location Survey from Thunder Bay to Lake Shebandowan.

Explorations and Surveys in 1875.

In the Mountain Region.

1. Exploration across the Rocky Mountain Chain by Smoky River Pass.

2. Exploration of the east branch of the River Homathco.

3. Location Survey from Bute Inlet to the mouth of the east branch of the River Homathco.

4. Trial Survey and location up the east branch of the River Homathco to its source in Lake Tatlayaco; and thence by a chain of small lakes to the River Chilanco (near Lake Tatla).

5. Continuation of the Trial Survey and location across the central plateau by a chain of lakes to the River Nazco; thence down the Nazco Valley to the River Blackwater.

6. Continuation of the location down the valleys of the Rivers Blackwater and Chilacoh, to the junction of the latter with the Stewart, about 15 miles west of Fort George.

7. Exploratory Survey along a portion of the Rivers Stewart and Fraser.

8. Location Survey from the Yellow Head Pass towards Tête Jaune Cache.

9. Exploratory Survey from Dean Channel by Salmon River, through the Cascade Mountains, thence to the Blackwater valley.

10. Exploratory Survey from Kemano Bay on Gardner Inlet to First Lake on the eastern slope of the Cascades.

11. Exploratory Survey of a line on Vancouver Island.

12. Trial location survey between Esquimault and Nanaimo.

In the Prairie Region.

13. Completion of Location Surveys between Selkirk (Red River) and Livingstone.

14. Exploration from Livingstone to Battleford and thence by River McLeod to Jasper valley.

15. Exploration up the Rivers Maligne and Rocky, towards River Brazeau.

16. Exploratory Survey from Livingstone westward to Battleford and the Hay Lakes.

17. Exploratory Survey from the Hay Lakes across the North Saskatchewan to Root River.

In the Woodland Region.

18. Survey with soundings of Lakes Shebandowan, Kashaboie, and Lac des Mille Lacs.

19. Survey from Lake Windigoostigan to Sturgeon Falls on Rainy River

20. Exploratory Survey from Lake Windigoostigan by Lake Shebandowan to River Oskondiga.

21. Exploratory Survey from Lake Manitou to Sturgeon Falls.

22. Exploratory Survey from Lake Vermillion to River Little Wabigoon.

23. Extension of Harbour Survey at the mouth of French River.

24. Exploration from Sault Ste. Marie to River Pic, Lake Superior

25. Exploratory Survey from Sunshine Creek, *viâ* Rivers Savanne and English, to River Wabigoon.

Explorations and Surveys in 1876.

In the Mountain Region.

1. Exploration from Gardner Inlet up the Kitlope Valley.

2. Trial Location Survey from Moose Lake near the Yellow Head Pass, *viâ* Tête Jaune Cache and the Grand Rapid of the Fraser, to the mouth of the Chilacoh, near Fort George.

3. Exploratory Survey from River Chilacoh, by its western branch, to the Falls of Rivei Blackwater.

4. Exploratory Survey from Salmon River, 36 miles from Dean Channel, by Nechaco and Stewart Rivers, to the mouth of the Chilacoh.

5. Trial Location Survey from Dean Channel, 53 miles up Salmon River.

6. Revised Location Survey from Waddington Harbour, 54 miles up the River Homathco.

7. Re-Survey along the Lower Fraser between Yale and Lytton.

8. Exploration southward and westward of Lake François.

In the Prairie Region.

9. Location Survey from River Pembina to River McLeod.

10. Exploratory Survey from River McLeod to River Athabasca.

11. Location Survey from opposite Edmonton to River Pembina.

12. Location Survey from River Myette down Jasper Valley to River Assineboine.

13. Exploratory Survey from River Assiniboine down the Athabasca Valley.

14. Exploration from the Willow Hills up Battle River to Buffalo Coulee.

15. Exploration up the River Myette to Yellow Head Pass.

In the Woodland Region.

16. Completion of Location Survey between Lake Superior and English River.

17. Trial Location Survey between English River and River Wabigoon.

18. Trial Location Survey between River Wabigoon and Lake Vermillion.

19. Trial Location Survey between Lake Vermillion and Keewatin (Rat Portage.)

20. Exploration from located line, by Dog Lake to Nepigon.

21. Exploration in a south-easterly course from River Pic towards French River.

22. Exploration in a north-westerly direction from French River towards River Pic.

23. Trial Location Survey eastward from Contin's Bay on French River, towards the eastern terminus.

Operations in the Mountain Region.

In the First Year.

1871.

At the commencement of the Survey, all the sources of information open to inquiry with regard to the passes through the Rocky Mountains, were consulted. After careful investigation it appeared that the two passes known as the Howse and the Yellow Head possessed advantages which, taken in conjunction with the approaches to them, as far as known, best warranted further examination.

It was, moreover, evident, that the obstacles which intervened between the passes and the coast of British Columbia were of a very serious character, and that the selection of the pass through the main Rocky Mountain range depended on the discovery of a practicable line across the whole mountain region.

(Commencement of the Survey.)

The survey did not begin in British Columbia until the 20th July, 1871, the day upon which that Province became incorporated into the Dominion. In the mountainous districts, field operations are always attended with difficulty and hardship after the first of November, so that there was but a short time during the open season of this year to carry on the exploration. Great energy was nevertheless bestowed on the work, and although attempts to find a practicable route on a direct course to the coast from either pass failed, information of great value was obtained.

It was found that there would be no difficulty in carrying a line from the valley of the River North Fraser, in the neighbourhood of Tête Jaune Cache, to the valley of the North Thompson, by a low and wide depression in the mountains in that quarter.

It was found that the valley of the North Thompson would, in all probability, admit of a line being constructed from Yellow Head Pass to Kamloops, a distance of 255 miles, with grades not exceeding 50 feet per mile.

The Yellow Head and Howse Passes.)

It was discovered that, while a practicable line might be had from the common point Kamloops, *viâ* Eagle Pass to Howse Pass, the line by Yellow Head Pass possessed several important advantages. It promised to be less costly; to have a generally better alignment, with less severe gradients and fewer difficulties of construction, and to be no longer than the Howse Pass route. Accordingly, the Yellow Head Pass was, for the time, selected, and further surveys through the main mountain range, by the Howse Pass, and other passes in a more southern latitude, were abandoned.

(The first practicable route.)

It was further found that it was possible to reach the coast from Kamloops by the course and outlet of the Rivers Thompson and Frazer, the line terminating at an excellent harbour on Burrard Inlet.

Thus, it was ascertained that a line was available for the Railway, through the entire Rocky Mountain Region, although portions of it would be enormously expensive.

(Comparative advantages of route.)

The report which I had the honour to submit, dated 10th April, 1872, pointed out generally the advantages of this line as compared with the Railway extending eastward from San Francisco to New York.

Those engineering features, which govern the cost of operating a railway and transporting goods, gave promise of being much more favourable on the Canadian route.

The United States Pacific Railway attains an altitude above the sea, at four different points, fully double the height of the great continental summit on the Canadian line, and for 1300 consecutive miles, there is no altitude so low on the railway between San Francisco and New York, as the highest summit of the line through the Yellow Head Pass.

With respect to distance, it was estimated, that, from Burrard Inlet to Montreal would be 633 miles less than from San Francisco to New York.

It was, at the same time, estimated that the Canadian route would bring New York, Boston and Portland, from 300 to 500 miles nearer to the Pacific Coast at Burrard Inlet, than these cities now are, with San Francisco as the terminal point of their line through the United States.

The distance from England to China, would be more than 1,000 miles less by the Canadian line, than by the line passing through New York and San Francisco.

In the Second Year.

1872.

The remarkable advantages of which the first year's Survey gave promise, are not attainable without encountering obstacles which call for formidable works of construction. A line, in itself practicable, had indeed been discovered, but the information gained by the rapid and necessarily imperfect exploration also indicated that to carry a railway through some of the gorges of the Rivers Thompson and Fraser, would require an enormous outlay. The difficulties, in fact, appeared so great that a recommendation to adopt the route discovered, could not be justified until every effort had been exhausted to obtain a line sufficiently favourable at less cost.

Accordingly, in 1872, the engineering staff was reorganized, and the work of Survey and Exploration was extended to embrace a wider area of operations.

(Failure to cross Cariboo Mountains.)

The attempt to find a direct route through the mountains from the Yellow Head Pass *viâ* Cariboo to the coast was continued. It resulted in a failure; no opening having been discovered in the lofty mountains which bar the way at Tête Jaune Cache, and which, at that point, turn the River Fraser more than a hundred miles out of a direct course to its outlet.

(Approaches to the Yellow Head Pass.)

Surveys east and west of the Yellow Head Pass confirmed the impression that a good line, not especially difficult of construction, could be had on both approaches to the great summit in the mountain chain. The Instrumental Surveys made from Tête Jaune Cache across Canoe River to Lake Albreda, and thence down the River Thompson to Kamloops, were, in the main, satisfactory, and the localities which called for further examination were established.

Survey to Bute Inlet.

An exploration and survey were made from the valley of the River Thompson, at a point some 70 miles north of Kamloops, to Bute Inlet. The difficulties met were great; but a practicable line was found. On leaving the Thompson, the line ascended by the River Clearwater to the central plateau of British Columbia, passed by Lac la Hache in a westerly direction, crossed the River Fraser above the big bend, and thence by the Chilicotin and Chilanco Rivers to the sources of the Homathco, which river it followed to its mouth at Waddington Harbour.

(Bute Inlet to Vancouver Island.)

From Waddington Harbour a survey was made along the northern side of Bute Inlet and across the Valdes group of Islands, by Seymour Narrows, to Vancouver Island, with the view of ascertaining how far it would be practicable to extend the railway to Esquimault, or other harbours on the Pacific coast of Vancouver.

(Exploration by Coquihalla Valley.)

An exploration was also made from Kamloops by Nicola Lake and the River Coquihalla to the River Fraser, near Hope, with the view of avoiding the heavy works in the canyons above Yale, and of shortening the distance.

(General *reconnoissance* of the region.)

These several explorations and surveys proved to be only preliminary to further works, as the difficulties met in a field of operations so extensive, in nearly each case, called for special examination. Nothing, however, was left undone to gain full information. The writer personally visited the region under survey, crossing over by the Yellow Head Pass; and he examined some of the harbours. He despatched an expedition to examine the passage through the mountains through which the Peace River flows, likewise the country extending to the coast. The Survey had also the advantage of the immediate supervision of Mr. Marcus Smith, who threw into the work an amount of energy and enthusiasm of which few men are capable.

(Three projected routes.)

At the end of 1872, three routes were reported :—

First,—The one from Yellow Head Pass by the Rivers Thompson and Fraser to Burrard Inlet.

Second,—A loop line, leaving the first at Kamloops and passing by the Coquihalla, to the River Fraser at Hope, thence to Burrard Inlet.

Third,—A line branching from the first at the confluence of the Rivers Clearwater and Thompson above Kamloops and extending to Bute Inlet, with a possible extension to Esquimault.

Not one of these lines could be considered satisfactory, and it became necessary to continue the work of the Survey.

In the third year.

1873.

This year it was deemed advisable:—

1st. To make a re-survey of portions of the line by the Yellow Head Pass, more especially between Moose and Cranberry Lakes.

2nd. That another attempt should be made to find a more direct passage than by the valley of the River Thompson, to the coast. Accordingly, an exploration was made *viâ* the River Horsefly and Lake Clearwater, towards the head waters of the River North Thompson.

3rd. That a line should be surveyed from Howe Sound, through the Cascade range to Lake Lillooet, and thence by Lake Anderson, River Bonaparte, and the most available route to the Thompson Valley. This survey extended over about 300 miles. Much of the field work was exceedingly difficult, and it occupied the whole season.

At the close of the year, the writer was enabled to report, at length, on all the routes which, up to that time, had been projected, and which had been examined.

It was submitted that the result of the explorations through the main Rocky Mountain chain, gives a satisfactory solution to what once threatened to prove a difficult problem.

(Advantages of the Yellow Head Pass confirmed.)

It became clear that there is no insurmountable difficulty in crossing the range at several points ; and that of all the passes between the southern boundary of British Columbia and the 53rd parallel of latitude, although at least one other pass north of the 53rd parallel has a lower elevation, the Yellow Head, from the character of its approaches, as well as from its geographical position, offers the most eligible route yet discovered from one side of the main range to the other.

The serious difficulties which remain, lie in crossing the great plateau to the more western coast range, in piercing the Cascade Mountains, and in descending through them from the level of the elevated plateau to the sea.

(Projected routes described.)

The results of surveys made have been so arranged as to form seven distinct routes between the longitude of Fort Edmonton on the North Saskatchewan and the Pacific coast, and for the purpose of comparing distances, have been made to converge to a common point near that longitude.

Route No. 1.—Begins at Burrard Inlet, near New Westminster, follows the Lower River Fraser to Fort Hope; passes up the Coquihalla Valley, and thence by Lake Nicola to Kamloops. At Kamloops it enters the valley of the River North Thompson, following which it passes over a low watershed at Lake Albreda to Canoe River, and thence crosses by Lake Cranberry to Tête Jaune Cache. From the latter point it

follows the River Fraser to one of its sources near the Yellow Head Pass, and thence by the Caledonia and Jasper valleys, to the eastern side of the Rocky Mountain chain; thence east by the Rivers MacLeod and Pembina to the North Saskatchewan.

The difficulties of this route lie in the first 128 miles—from Hope to Kamloops—involving an ascent of 3,513 feet, with gradients ranging as high as 172 feet in a mile, and calling for tunnelling; the aggregate length being estimated at five miles On the remaining 544 miles to Edmonton, favourable gradients and light work may be obtained.

Route No. 2---Begins at Burrard Inlet, and, like *Route No.* 1, follows the River Fraser to Hope, but instead of crossing the Cascade chain by the Coquihalla valley it continues to ascend the River Fraser to Lytton. At the latter point it passes into the valley of the River Thompson, and follows the course of that river to Kamloops, afterwards taking the same course as *Route No.* 1.

Between Hope and Kamloops the distance is 165 miles, but the character of the section is far from favourable. There are formidable difficulties along the canyons of the Rivers Fraser and Thompson, owing to the extremely narrow gorges through which these rivers flow. The work would be enormously heavy, and the cost proportionately great.

Route No. 3---Begins at Howe Sound, crosses the Cascade Mountains to the River Fraser at Lillooet, and thence passes over the plateau in the centre of British Columbia by the Marble Canyon and River Bonaparte valley, to the River North Thompson, near the mouth of the River Clearwater. From this point it ascends the valley of the River Thompson, and thence takes the same route as Nos. 1 and 2.

The 284 miles from Howe Sound to the River North Thompson involve unusually difficult gradients and heavy works of construction.

Route No. 4---Commences at Waddington Harbour, on Bute Inlet, and ascends by the valley of the River Homathco, through the Cascade chain to Lake Tatla. Thence it passes over the Chilicotin plains to the River Fraser; crossing the Fraser below Soda Creek, it continues eastwards to Lac la Hache and Lake Canim, and reaches the

River Thompson valley near the mouth of the River Clearwater. Thence, it follows the same course as the routes previously mentioned.

From its starting point to the valley of the River Thompson, the distance by this route is 378 miles, involving a passage over three lofty summits, which would require steep gradients and works of an excessively heavy character, embracing cuttings in granite and a great number of short tunnels.

Route No. 5—A modification of the previous route, the result of partial explorations, by which the difficulties found on that route may, possibly, be avoided. This route may be found, on further investigation, to be deserving of consideration. The expenditure for the first 44 miles from the coast would be heavy, but the average on the other portion, it is hoped, would be moderate.

Route No. 6—Is a projected route from Bute Inlet by the Chilicotin plains to Fort George, and thence by the upper River Fraser to Tête Jaune Cache, where a junction is effected with the route through the Yellow Head Pass to the east.

This route, in its more difficult portions near the coast and from Tête Jaune Cache eastward to the Pass, has been surveyed instrumentally. The general physical character of the country through which the remaining portion of it extends is such that a practical, and even a favourable line, may be regarded as probable. From the beginning of the survey, it has been viewed as an available route in the event of the obstacles which are met with in the southern lines being held to be insuperable, or too serious to be encountered owing to the magnitude of the works which they might demand.

Route No. 7.—This route, starting from the North Bentinck Arm of the sea, follows the Bella Coola gap in the Cascade Mountains, and crosses the plateau to the Giscome Portage; going thence by Fort McLeod to the River Peace, which it follows through the mountains.

The information obtained concerning this route is only of a general character. It is believed, however, that up to within 300 miles of the sea, no higher elevation than 2,000 feet need be crossed; but the passage of the Cascade Mountains would necessitate an ascent of some 600 feet above the level of the Yellow Head Pass.

Little can be said regarding the practicability of reaching the Pacific at other points than those enumerated.

Lieut. Palmer made an exploration from Bentinck Arm into the interior. With that exception, no examinations have been made in the country lying between Bute Inlet and the River Skeena, a distance of some 300 miles, since it was first visited by Vancouver and Mackenzie in 1793.

Information on the subject is based mainly on the hearsay reports of Indians; and the possibility of advantageously crossing the Cascade Mountains from the East to the coast, in a more northerly direction than the routes indicated, can be nothing more than mere conjecture.

(Line from the mainland to Vancouver Island.)

The attempt made to find a line for the railway from the mainland to Esquimault on Vancouver Island did not result satisfactorily. For a distance of 50 miles west from Waddington Harbour the only course is to follow the edge of the high rocky bluffs which skirt Bute Inlet, a line involving the formation of a number of short tunnels and requiring much heavy work.

(Formidable bridging required.)

The most serious difficulties, however, present themselves in passing from the mainland across the Valdes group of islands to Vancouver Island. The bridging found necessary within a distance of 30 miles is indeed not only formidable, but without precedent. Besides tunnelling and heavy rock excavations, the following works are called for:—

One clear span bridge of		1,100 feet,	at Arran Rapids.
"	"	1,350 "	at first opening of Cardero Channel.
"	"	1,140 "	at second opening of Cardero Channel.
"	"	640 "	at third opening of Cardero Channel.
"	"	1,110 "	at Middle Channel.
"	"	1,200 "	at first opening of Seymour Narrows.
"	"	1,350 "	at second opening of Seymour Narrows.

The whole distance from Waddington Harbour to Esquimault may be computed at about 240 miles. The exploration showed that the work on some 25 miles near Esquimault would prove heavy; the remainder of the distance comparatively light.*

* *Vide* Report, January, 1874.

In the fourth year.

1874.

Before the close of winter, another examination was made of that section of the country lying between the Rivers Clearwater and Thompson, along the general direction of Blue River. The object of this examination was further to test the practicability of the projected Route No. 5 of last year, and to prepare for an instrumental survey, should circumstances warrant it. The exploration, however, did not result satisfactorily. A line was deemed possible, but with gradients so unfavourable, and with works of construction so heavy, that any further expenditure on a survey in this quarter was considered inadvisable.*

(Renewed efforts to cross the Cariboo Mountains.)

An attempt was likewise made at another point to pierce the mountain range which walls off the River Thompson and that portion of the River Fraser below Tête Jaune Cache, from the central plateau of British Columbia. There were still some hopes that a break in the range might be discovered in a north-easterly direction from Lake Clearwater. A partial examination made late in the previous season gave promise that such an opening might be found. The information obtained from this exploration set positively at rest the question of a direct practicable route across the Cariboo range from the Yellow Head Pass to the coast. The summit of the divide at the lowest place that could be found on this route was an immense glacier 7,000 feet above sea level.

(Re-examination by the Coquihalla.)

A re-examination was made of that part of the route which lies between Kam loops and the Lower Fraser, by the Coquihalla Pass. It was found that while important changes could be effected on the line as originally surveyed, the gradients would still remain unusually severe, and the works of construction would be extremely troublesome and expensive. The climatic objections to the route were also confirmed.

(Exploration by the Similkameen Valley.)

An attempt was made to find a new route across the Cascade Range to the south of the Coquihalla. The object was to trace a line to connect the Fraser, below Hope,

* *Vide* Appendix D, page 101, Report by Joseph Hunter.

vid the Similkameen valley, with one of the lines in the interior already established and thence across the main Rocky Mountain chain. This exploration resulted in failure; no practicable line was found.*

(Exploration by the Tulameen Valley.)

A final effort was made to find a route through this section of the Cascade range, by a branch of the Coquihalla and the course of the River Tulameen; but it proved still more unsatisfactory, the way being completely barred by mountains.*

(Survey along the Lower River Fraser.)

The instrumental survey made this year from Fort Hope to Burrard Inlet was so far satisfactory as to establish the fact that the line was perfectly feasible and the gradients favourable, although the bridging of the wide and deep river channels would be expensive. Three tunnels appear to be necessary, having a total length of 3,400 feet, but only at a few other points would the work of excavation be heavy.

It was considered important to obtain exact data in order to form a reliable estimate of the difficulties to be encountered along the canyons of the lower Rivers Fraser and Thompson. The engineering force available was insufficient to make a minute survey of all the very serious difficulties encountered, extending as they do successively for seventy miles. It was deemed advisable, under the circumstances, to select an average section of the canyons for examination; accordingly, a trial location survey was made for a distance of fourteen miles up the Fraser from Yale. On this fourteen mile section the survey showed that tunnels of an aggregate length of 6,385 feet, together with formidable rock cuttings, would be required. Favourable undulating gradients could, however, be obtained.

(Re-survey from Lake William to the Chilicotin Plateau.)

A trial location was made to improve the difficult portions of the route designated No. 4 (*vide* report, Jan., 1874) from Lake William across the River Fraser to the Chilicotin Plateau, and it was found that the difficult work reported may be considerably reduced. In the first nine miles, the work would be heavy, with a steep

* *Vide* Appendix E, page 105, Report by John Trutch and H. J. Cambie.

grade for three miles of about 100 feet per mile. The line would then require to cross the Fraser by a single span of 1,100 feet from cliff to cliff, at a height of 390 feet above the water. The tunnelling would be reduced from a total length of 3,500 feet to 800 feet.

Another portion of the route No. 4 between Lake Canim and Clearwater valley was likewise surveyed, with the result of showing that the heavy works on this section may be greatly lightened, should a careful location survey be made.*

(Survey from Yellow Head Pass to Fort George and Bute Inlet.)

The failure which attended the several attempts to find a direct route from the Yellow Head Pass across the Cariboo range of mountains to the coast, together with the unsatisfactory character of the lines already surveyed to Burrard Inlet, Howe Sound and Bute Inlet, led to an instrumental examination of the route from Tête Jaune Cache down the valley of the River Fraser to Fort George, about 210 miles, and thence across the country toward the line previously explored, to Bute Inlet. The length of line under examination, over 500 miles, and its remoteness from any base of supplies, rendered it impossible to finish the whole survey in one season. Some of the parties met and connected their work, but others, engaged between Fort George and the coast, failed to do so. A gap of some 50 or 60 miles remained unexplored. The knowledge acquired from this survey gave promise that a practicable line, with favourable gradients, and with comparatively light work might be obtained.

(Exploration inland from Dean and Gardner Channels.)

It was considered advisable likewise to extend the explorations in a northerly direction. Scarcely anything was known of the country between the latitude of Bute Inlet and the River Skeena. The coast, it is true, had been explored and mapped by Vancouver in the last century, and had occasionally been visited; but the country extending inland for a breadth of over 200 miles, was virtually a blank on the map.

It was therefore deemed advisable to direct attention to this unexplored region.

* *Vide* Appendix F, page 107, Report by Marcus Smith.

Accordingly, in the season of 1874, explorations were commenced. The various inlets on the coast were examined; the interior was traversed, and some knowledge of its general features was obtained.*

Barometric surveys were made from the Dean and Gardner Inlets, and from other points on the coast, to ascertain the elevation of the lowest depression in the Cascade Mountains. These various examinations furnished information which justified the expense of a survey the year following, from Fort George to Dean Channel, and gave foundation for the impression, that, with the exception of difficulties on the extreme western section of twenty miles, a favourable line might be secured to Gardner Inlet from the northern bend of the River Fraser, near Fort George.

In the Fifth Year.

1875.

(Exploration from Fort George to Edmonton, *viâ* Smoky River Pass.)

The operations of this year were commenced in mid-winter, by sending a party across the Rocky Mountains from the northern bend of the River Fraser, *viâ* the Smoky River Pass.

The party left Fort George on the 14th of January, pursuing an easterly course along the north fork of the Fraser, between the 54th and 55th parallels of latitude. The north branch of the river was followed to its source, which was discovered in a semi-circular basin, completely closed in by glaciers and high bare peaks. The southern branch was then followed, and for about fifty miles the course was favourable. The route then entered the heart of the Mountain Range, still ascending with easy grades for some twenty miles further. The ascent rapidly attained the highest point or continental "divide" at 5,300 feet above the sea. The exploration then continued in an easterly direction along the flank of the mountains, to the River Athabasca, not far below Jasper House. By this exploration we obtained a correct knowledge of the geography of the region, and established the fact that a railway might be carried through the Smoky River Pass; but that no object would be accomplished which could not be much more easily and better attained by adopting the Yellow Head Pass.

* *Vide* Appendix G, page 137, Report on exploration by Charles Horetsky.

The party engaged on this hazardous expedition, in the course of their journey, travelled 900 miles on snow shoes. They suffered unusual hardship. For twenty days in January the thermometer averaged 39° below zero, the minimum being 53°. Many of their dogs perished; their dog trains became completely disabled, and they had eaten every morsel of their provisions three days before they reached the nearest Hudson's Bay Fort.*

(Exploration of the Nazco Valley.)

As a preliminary to beginning an instrumental survey, a party was sent early in the winter to explore that portion of the line in the Nazco Valley, left unsurveyed, between Fort George and Bute Inlet, at the close of 1874. Before the opening of spring, they reported that there were no serious obstacles to be encountered.

(Concentration of operations.)

In previous years, surveying operations had been widely divergent, increasing the difficulty of supervision, as well as adding to their cost. There was no longer necessity for this condition of things, as the field of enquiry in the Southern and Central Districts of British Columbia, had been well travelled over. Accordingly, it was deemed expedient to confine the survey operations of this season to the country to the north of Bute Inlet and Tête Jaune Cache. It was also determined to make a location survey on Vancouver Island from Esquimault to Nanaimo.

(Trial location from the Yellow Head Pass to Fort George and Bute Inlet.)

The reported results of the Smoky River expedition also pointed to the expediency of making a trial location from Yellow Head Pass, down the valley of the River Fraser to Fort George and thence across the country by the Nazco valley, to the Homathco and Bute Inlet.

Five parties were selected for this work, and as the season for operations was advanced before those detailed for the survey lying between Fort George and Yellow Head Pass could reach that locality, arrangements were made for them to winter in the mountains. They were thus enabled to take advantage of any opportunity for carrying on field operations during the winter, and in the following season to save the time usually taken to reach these distant stations.

---

* *Vide* Appendix H, page 145, Report and narrative by E. W. Jarvis.

A trial location was completed nearly the whole way from Waddington Harbour to River Stewart by the Nazco valley. The survey was carried through the Cascade mountains by the east branch of the Homathco, where a more favourable line was obtained than that by the west branch, giving an easier ascent to the central plateau, with less tunnelling and heavy work. In the locality of the Blackwater and Chilacoh Rivers, difficulties were met, which called for a revision of the surveys at this point.

(Survey from Fort George to Dean Channel.)

An exploratory survey was made from the Kamsquot Bay, on the Dean Channel up the valley of Salmon River, intersecting the line to Bute Inlet from Fort George in the valley of the Blackwater. This examination gave promise of a comparatively favourable line to Dean Inlet, some 50 miles shorter than the line to Bute Inlet.

(Explorations at Gardner Inlet)

The explorations made at Gardner Inlet were not satisfactory. A line of measurements was made from Kemano Bay by a valley across a depression in the Cascade Mountains. The survey terminated 22 miles from Kemano Bay, where a Lake was found flowing in the opposite direction from the coast. This Lake proved to be not more than 2,790 feet above the tide, but an intervening ridge, 4,019 above sea level, would require to be tunnelled.

(Pine River Pass.)

An exploration made in the course of the year, confirmed the fact reported by Indians, that a depression in the Rocky Mountains existed some 50 or 60 miles south of Peace River, designated Pine River Pass. It appears to be of no great altitude, and of sufficient importance to justify further examination should it be deemed advisable to incur the expense of continuing the survey to any points further north than those which have been under consideration.*

A description of the survey operations during the year, with full details, will be found in the Appendix.†

* *Vide* Geological Report by Alfred R. C. Selwyn, 1876, page 68.
† *Vide* Appendix I, page 162, Report by Marcus Smith on Surveys made in 1875.

In the Sixth Year.

1876.

(Winter examination of the coast.)

The work this year began with a winter examination of the coast. Little or nothing being known of the climatic condition of the several deep Inlets or Fiords which indent the mainland, except during the summer, it was considered necessary to gain some knowledge of them in winter. An expedition was accordingly despatched by steamer, at the beginning of February, to obtain as much information as possible respecting the formation of ice in the different channels, and to make special explorations on shore in the valley of the Kitlope.

Much ice was reported in Gardner Inlet. The steamer first struck it at about 25 miles from the Head. The Indians met there stated that the Inlet had been frozen over for about a month, and, as the ice remained until April, a considerable extent of this Inlet must have been unnavigable for fully three months.

The Indians at the same time stated that the phenomena of that winter were not in accord with those generally experienced; that Gardner Inlet was seldom frozen to the same extent as it then was, and that the greatest distance the ice had been known to extend down the Inlet was to a point about two miles below Kemano, and that even this extent was of rare occurrence. Above Kemano it is not surprising that the water should freeze when the temperature is low. The inlet is narrow and land locked, and the water, which is reported nearly fresh, is rarely ruffled by a breeze.

The Indians stated that Dean Inlet had been frozen for a short time, but that there had been no ice at Bute Inlet during the winter.

Snow slides are reported as formidable difficulties in many localities in the Cascade range. Where the mountains are steep they are most frequent. In some places, acres of thick masses of snow, carrying trees and boulders, slide down the mountain sides with great violence.*

(Unsuccessful attempt to cross the Cascades.)

The exploration made in 1874 and 1875, between Dean Inlet and Lake François, still remaining unconnected with the examination made from Gardner Inlet, it was

* *Vide* Appendix J, page 177, Report on winter examination, by C. H. Gamsby.

deemed advisable to fill up the intervening gap with as little delay as possible, as future operations might be determined by the result obtained.

Accordingly, the party sent from Victoria in February was directed to perform the work, if possible. The weather, however, proved unfavourable. The snow was so deep that every effort was fruitless. After great labour the party succeeded in making an exploration up the River Kitlope, 46 miles, discovering that the source of that river is in a basin or low "divide," between the waters of the Dean and Gardner Inlets. They did not, however, succeed in passing across the Cascade chain.

(Severity of the winter.)

The severity of the winter of 1875-6 in British Columbia, was, according to every account, beyond precedent. This circumstance was so far fortunate, as it afforded evidence of the more marked climatic difficulties to be contended against. The snow-fall was great, and the floods in spring time were unusually heavy, indicating where precaution is necessary in locating the line.

(Completion of the trial location to Bute Inlet.)

A trial location survey was completed from the Yellow Head Pass, by the banks of the Fraser to Fort George, and across the country to the Homathco, where a re-survey and location has been effected through the Cascade chain to Waddington Harbour. Great improvement has been made on the line first traced. It is not possible to avoid tunnels and heavy rock excavations along the descent by the Homathco to the sea, but it is found that the quantity of work first deemed necessary, can be much reduced. The last survey shows eight tunnels, with an aggregate length of 1¼ miles, on the first 46 miles east from Waddington Habour; and six tunnels, in all ¾ of a mile long, thence to the Yellow Head summit; a total aggregate on this route of 14 tunnels, the length being 2 miles on the 547 miles of line. The heaviest ascents from the sea are 105·6 feet, 84 feet and 66 feet per mile. The aggregate length of the first is 13¼ miles, and of the two latter, 3 miles. At no point on the remaining length do the gradients exceed 52·8 feet per mile.

(Trial location to Dean Inlet.)

The trial location survey from the Dean Channel, by the Salmon, Blackwater and Iscultaesli Rivers, to a point of intersection with the Bute Inlet line, in the Chilacoh valley, has resulted favourably. The line to Dean Inlet is 55 miles shorter than to

Bute Inlet. There are, however, 8 miles of a gradient, 113½ feet per mile, one mile of 105·6 feet and 19 miles, ranging from 65 feet to 92 feet per mile. With the exception of these 28 miles, there is no gradient over 52·8 feet per mile, between Dean Inlet and the Yellow Head summit. For a distance of 20 miles, heavy bridging and excavation will be called for, together with 13 tunnels of an aggregate length of 2 miles.

(Alternative line to Dean Inlet.)

The exploratory survey of an alternative line from Dean Inlet has been made. It leaves the Salmon River about 45 miles from tide water, crosses a "divide" to waters which flow in a north-easterly direction, and follows the course of the Rivers Euchu, Nechaco and Stewart, to a point near Fort George. With some exceptions, the gradients and works of construction on this line would be easy, but its length is 15 miles greater than the more southern line to Dean Inlet.

(Exploration inland from Gardner Inlet.)

The exploration made this year, south and west from Lake François, developes the fact that a favourable line, with light gradients, from Fort George to within 22 miles of Kemano Bay, on Gardner Inlet, can be secured. On the remaining 22 miles, however, grave difficulties are to be met.

(Re-survey between Yale and Lytton.)

The re-survey along the River Fraser, between Yale and Lytton, establishes the entire practicability of the line between these points. Easy undulating gradients may be secured, but the works of construction will be heavy.

A detailed account of the several explorations and surveys, together with a description of the engineering character of the lines examined and results to date, is presented in the Appendix.*

THE WORK ACCOMPLISHED IN THE MOUNTAIN REGION.

The results of surveys in the Mountain Region may be thus recapitulated:—

The information obtained is tolerably complete as regards the greater part of the country between the southern boundary of British Columbia and the 56th parallel. The examinations in this region have extended over a breadth of seven degrees of

---

**Vide* Appendix K, page 182, Memorandum by H. J. Cambie; also, Appendix T, page 254, Description of the engineering features of lines in British Columbia, by Marcus Smith.

latitude by fifteen degrees of longitude. The only portion respecting which our information is deficient, is the district bordering on and drained by the River Skeena and its tributaries.

(The Rocky Mountain Passes.)

Six passes through the main Rocky Mountain chain have been examined: the Peace River, the Pine River, the Smoky River, the Yellow Head, the Athabasca and the Howse. Two of them, the Howse and the Yellow Head, have been regularly surveyed. These examinations, together with the surveys and explorations which have been made throughout the contiguous districts, show that beyond question the advantages of the Yellow Head Pass,----every consideration being taken into account,—outweigh those of any of the other passes; that the opening at that point offers superior facilities for carrying the line of railway through the main range of the great mountain chain ; and in fact that the Yellow Head Pass, better than any other, opens the way to every harbour on the coast, from the straits of Juan de Fuca to the latitude of Dean Inlet.

The harbours north of Dean Inlet are equally accessible by the Yellow Head Pass. It is possible, however, but by no means certain, that the more northern harbours may be reached with greater ease by one of the more northern passes of Pine or Peace River. Accordingly, the selection of a terminus on Gardner Inlet, or at Port Essington, would call for more extended examinations in the mountains in the northern latitudes. Indeed, regular railway surveys, from the coast, *via* Pine River and Peace River, to the prairie region to the east, would be required, to obtain data for comparison with the Yellow Head Pass, and to determine which of the routes may be preferable.

While the question of the Pine River and Peace River Passes, in connection with lines to the two most northern harbours, is yet undecided, it is, however, undoubtedly established that the main Rocky Mountain chain can be crossed with ease by the Yellow Head Pass. The major problem is accordingly satisfactorily solved, and it remains to be considered how the minor ranges of mountains, and the other physical obstacles which present themselves, may be surmounted or avoided.

(Route through the Yellow Head Pass.)

Starting from the Athabasca, a river on the prairie side of the main chain, at a point known as old Henry House, the line enters the approach to the Yellow Head pass, and follows a westerly course through a fine, meadow-like expanse, lying fully a vertical mile lower than the lofty peaks which rise up on both sides. Passing through this low, open, and favourable passage, the line continues in its due westerly course, in all, some 60 miles from old Henry House, to Tête Jaune Cache. At this point, it intersects a remarkable valley, sunk deep in the mountains, and stretching for more than 400 miles in a nearly straight north-westerly and south-easterly course.

To the north-west, it is occupied by the River Fraser, and to the south-east by the Canoe River, to Boat Encampment, and thence by the Columbia and the Kootenay Rivers to beyond the international boundary line. This extraordinary valley is at an elevation of from 2,000 to 3,000 feet above the sea, while at no great distance from it on the north-eastern side, the crests of the Rocky Mountains, stand erect from 10,000 to 15,000 feet in altitude.

(Deflection of Route.)

Lofty mountain masses extend on the opposite side of this deep-lying and singularly straight valley or trough. These mountains are continuous and unbroken, except at two points. The most southern opening is abreast of Boat Encampment, where the Canoe River flows into the Columbia, and where the latter river all but completely reverses its course, and flows south through the passage. The more northern opening, not far south of Tête Jaune Cache, contains Lake Albreda, which, at certain seasons of the year, discharges its waters both north and south, the southerly discharge feeding the River Thompson. The Thompson itself flows in this locality nearly due south, and is walled in between the Columbian range on the east, and the southern extension of the Cariboo Mountains on the west.

(Unsuccessful efforts to pierce the Cariboo Mountains.)

Many fruitless attempts have been made to carry the railway line through the colossal wall of mountains which presents so imposing a barrier to its westerly course for so many miles north and south of Tête Jaune Cache. So far as

known, every depression has been examined, and every indentation explored, without success. The few lateral valleys, which at wide intervals exist, immediately terminate in gorges, again to disappear in glacial sources at high altitudes.

It is evident that at Tête Jaune Cache, two courses only are open for the railway. The one in a north-westerly direction by the Fraser and the great valley described; the other due south by the Albreda and the River Thompson. By either of these two routes the lofty and defiant Cariboo Mountains may be flanked, and the great plateau in the interior reached.

(The Central Plateau.)

Between the 49th and 50th parallels, the greater portion of the central plateau of British Columbia has a general uniformity of altitude, varying from 3,500 to 4,000 feet. Many of the rivers are sunk deep below the general surface, and the plateau is crossed here and there by irregular hilly ranges of considerable elevation. Towards the north-west, the plateau passes into a somewhat lower level, with many lakes, lying at a general elevation of more than 2,000 feet above the sea. In this section the river valleys are less sharply cut than those described farther to the south-east, and are, in consequence, more favourable for railway construction.

(Lines through the Cascade Mountains.)

The Cascade chain, which rises between the central plateau on the one side and the coast on the other, presents everywhere formidable difficulties. It has now been pierced by at least twelve different lines, five of which have been surveyed with transit and level, the others have been explored and barometric measurements made. Of the twelve lines, it is known that the five instrumentally surveyed are practicable for railway construction, and it is believed that three others can be placed in the same category, making in all, eight lines from which a choice may be made. The remaining four can be left out of consideration. The eight lines referred to are as follows:—

By the Coquihalla to Burrard Inlet.

By the Fraser to Burrard Inlet

By the Lillooet and Lake Anderson to Howe Sound.

By the East Branch of the Homathco to Bute Inlet.

By the West Branch of the Homathco to Bute Inlet.

By the River Bella Coola to the North Bentinck Arm.

By Salmon River to Dean Inlet.

By the Kemano Valley to Gardner Inlet.

By the River Skeena to Port Essington.

Although these eight lines through the Cascades may be viewed as practicable, one of them, that by the West branch of the Homathco, is substantially a loop line between two common points, and being less favourable and more costly than the line by the East branch of the same river, is practically superseded by the latter.

On the other hand, the surveys across the central plateau have led to the combination of portions of one or two lines, so as to form distinct lines, thus resulting in eleven definite routes.

(Routes from the Yellow Head Pass to the coast.)

These routes are classified in groups to facilitate comparison. The Southern group comprises those terminating at points near the extreme southern limit of the coast of the mainland. The Central group embraces those lines converging at Bute Inlet, opposite the middle portion of Vancouver Island. The Northern group embraces those routes which lead to harbours on the coast, entirely to the north of Vancouver Island.

SOUTHERN GROUP.

Route No. 1.—From Yellow Head Pass, *viâ* Lake Albreda, River Thompson, Lake Nicola and Coquihalla Valley to Burrard Inlet.

Route No. 2.—From Yellow Head Pass, *viâ* Lake Albreda, River Thompson and the Lower River Fraser, to Burrard Inlet.

Route No. 3.—From Yellow Head Pass, *viâ* Lake Albreda, Rivers Thompson, Bonaparte and Lillooet and Lake Anderson, to Howe Sound.

CENTRAL GROUP.

Route No. 4.—From Yellow Head Pass, *viâ* Lake Albreda, River Thompson River Clearwater, Lac-la-Hache, River Chillicotin, and East branch of River Homathco, to Waddington Harbour.

Route No. 5.---Alternative route to No. 4. Discussed in former progress reports, but now abandoned.

Route No. 6.---From Yellow Head Pass, *viâ* River Fraser, Fort George, River Chilacoh, River Nazco, and East Branch of River Homathco, to Waddington Harbour.

NORTHERN GROUP.

Route No. 7.—From Yellow Head Pass, *viâ* River Fraser, Fort George, River, Chilacoh and Bella Coola, to North Bentinck Arm.

Route No. 8.—From Yellow Head Pass, *viâ* River Fraser, Fort George, River Chilacoh, River Blackwater and Salmon River, to Dean Inlet,

Route No. 9.—From Yellow Head Pass, *viâ* River Fraser, Fort George, River Nechaco and lower portion of Salmon River, to Dean Inlet.

Route No. 10.—From Yellow Head Pass, *viâ* River Fraser, Fort George, River Stewart, River Nechaco and Kemano, to Gardner Inlet.

Route No. 11.—From Yellow Head Pass, *viâ* River Fraser, Fort George, River Stewart and River Skeena, to Port Essington.

(The routes to Northern harbours.)

The two last on the list, No. 10 and 11, are but imperfectly known. Enough, however, has been learned respecting the position and levels of the lakes and rivers and the general topographical features of the country on these routes, to justify the belief that further and more accurate surveys would result in obtaining feasible railway lines.

It is not supposed that these lines would be free from engineering difficulties. Indeed, it may be assumed that heavy work would be unavoidable in the descent from the level of the lake district, in the interior, to the sea, through the Cascade range. The extent of these difficulties, and the best mode of overcoming them, can only be ascertained by instrumental surveys.

In the meantime, it is deemed advisable to keep these northern routes in prominence, on account of the advantages which they undoubtedly possess, viewed in connection with the question of through traffic.

(The routes open for consideration.)

These eleven routes, reduced to ten by the abandonment of Route No. 5, terminate on the coast of the mainland at seven distinct harbours, and they all converge to Yellow Head Pass. To the number may be added the two additional routes, running east from the two most northern harbours, by the low-lying passes at Peace and Pine Rivers. Thus, we have in all, a dozen routes across the Mountain Region open for consideration, but for the reasons set forth, a comparison of them will be limited to the ten especially described.

Operations in the Prairie Region.

In the First Year 1871.

The prairie country merges into the woodland between Red River and Lake of the Woods. An arbitrary dividing line between the two Regions might be drawn at any point in that locality; but as it will be found convenient during construction, to carry the limit of the Woodland Region west to the well-established point, Selkirk, it has been deemed advisable to consider the Prairie Region to be bounded on the east side by the Red River and Lake Winnipeg.

(Limits of the Prairie Region defined.)

For similar reasons, it is expedient to adopt a well-defined boundary line on the western side of the Central Region. In general terms, the Rocky Mountains have been taken as the western boundary. These mountains undoubtedly form bold, geographical land marks. On their eastern side they rear themselves high above the adjacent country, and from their lofty crests, here and there, great spurs or subsidiary mountain masses project, which stretch out into the lower level, forming intermediate valleys, so that a line along their base would be extremely sinuous and difficult to trace. Moreover, explorations in the Mountain Region have, for the most part, been confined to the country on the western side of the various passes. As these passes are found on the line of boundary of British Columbia, the eastern limit of that Province is a convenient division line between the Central and Western regions of the survey.

The Prairie or Central Region will therefore be assumed to extend from Red River and Lake Winnipeg on the east, to the boundary of British Columbia on the west.

(General Characteristics.)

It will not be necessary to describe the physical characteristics of the Prairie Region, a full description having already been given in previous reports *

(Previous Explorations.)

1871

The explorations made by the Imperial Government, within the limits of the Prairie Region, suggested that no complicated difficulties of construction would be experienced. The information obtained, however, indicated that, as the rivers which drained the region flowed for the most part in deeply eroded channels of great width, the bridging might prove a serious consideration. Special information on this point, therefore, became indispensable. It was equally necessary to obtain further data relative to the approaches to the several mountain passes.

(Commencement of Examinations.)

Accordingly, in 1871, parties were sent out to examine the Plain Country in different directions, between Red River and the mountains. The information obtained, confirmed the view that in many sections the great river channels could not be crossed without great cost. Difficulties of this character promised to be least formidable on one route; that by Lake Dauphin and the valley of Swan River, to the level of the first prairie steppe, near Fort Pelly, and thence proceeding nearly due west to the South River Saskatchewan, which it crosses about latitude 52° 22′. The channel in this locality was found comparatively easy for bridging. West of the crossing of the South Saskatchewan, a line was projected to cross the North Saskatchewan at one point only; which crossing, it was considered, might be effected at some distance above Edmonton. It was hoped that the enormously wide and deep troughs through which the rivers of the plains in many places flow might be best overcome by the line being turned in the direction described.

The explorations were extended in a westerly direction to Rocky Mountain House and Kootenay Plain, near Howse Pass; as well as to the River Athabasca, as far as Jasper House. Branch explorations were likewise made to Lac la Biche, 100

*Vide Report January 1874, page 6.

miles to the north of the North River Saskatchewan and to other points. Important special information was thus obtained respecting a wide extent of country.

The total distance travelled by these parties, west and north, from Red River, was fully 5,900 miles.

In the Second Year

1872.

The knowledge acquired in the previous year, and the open character of the country, which admits of rapid examination, were considered a sufficient reason for postponing regular railway surveys in this district until the work in the mountains and woodlands, to the west and east, was further advanced. There were, therefore, no examinations made in 1872, beyond the general *reconnaissance* of the writer throughout the entire field of survey. A report of this journey has already been made public.*

(Peace River District.)

In connection with the personal *reconnaissance* referred to, explorations were made of the Peace River District by members of the expedition, detailed for that purpose. A wide extent of country, far to the north of the Saskatchewan, was reported as being unsurpassed in fertility; and, notwithstanding its high latitude with a comparatively dry and salubrious climate.

In the Third Year

1873.

When the writer was travelling through the Prairie Region in 1872, difficulty was occasionally experienced in finding water suitable for the daily wants of the party. The subject was brought under the notice of the Government, and recommendation was made to have the water-bearing qualities of each locality tested, and at points where a sufficient surface supply was not found, to sink experimental borings. By this means it was hoped that the possibility of obtaining water by ordinary, if not by artesian wells, would be established.

---

*Vide Report January 1874, pages 11 and 35, also "Ocean to Ocean."

(The question of water supply.)

This duty was placed under the supervision of the Director of the Geological Survey, who undertook an investigation with regard to the water supply and the question of mineral fuel along the entire length of the Saskatchewan, between Rocky Mountain House and Lake Winnipeg.

(Internal Navigation.)

During this season, surveys were made of the portages and streams between Lakes Winnipeg, Manitoba, Winnipegoosis, and the River Saskatchewan, at Cedar Lake, with the view of ascertaining how far these several waters could be made available for navigation.

In the Fourth Year

1874.

Examinations which had been made, established: 1st—That to carry the line from Red River *viá* the south of the Riding Mountains, would involve much heavy work in crossing the deep and wide valleys of the Assiniboine and its tributaries. 2nd—That by making a divergence by the east and north of the Riding and Duck Mountains, and up the valley of Swan River, the heavy work would be avoided, but that the latter course would necessitate a considerable detour from a direct line. Accordingly, further examinations were called for.

(Route by the Narrows; Lake Manitoba.)

A survey of the Narrows of Lake Manitoba was made with the view of ascertaining how far it would be practicable to bridge these waters. It was found that at the Narows of the Lake, the width of the main opening is only 2,650 feet, with an average depth of 10 feet, and that the railway may be carried across at this point at little expense compared with the saving effected in avoiding the heavy work or the detour on the other lines which had been projected. By crossing at the Narrows, it was found that the length of the line is shortened about 30 miles.

(Selkirk to Livingstone.)

During the summer and autumn, an exploratory survey was made from the crossing of Red River at the Town Plot of Selkirk, in a nearly due north-westerly direction, by the "Narrows" to the turn of the Duck Mountains, and thence up the valley of the Swan River to Livingstone.

The whole distance is over 270 miles. It was established that for 200 miles the line will have but few curves, and will be otherwise favorable. The line of survey was pushed to the north of the Duck Mountains, their northern edge forming an important objective point.

Between the Duck Mountains and the Porcupine Mountains, the River Swan flows in a north-easterly direction to Lake Winnipegoosis. The line, in ascending this valley, passes to the south of an isolated elevation named Thunder Hill, rising to 1,937 feet above sea level. This survey shewed light average earthworks, with heavy bridging only on the last thirty miles. In the latter section, there are six gullies of about 1,000 feet wide, from 50 to 80 feet deep.

(Character of the Country Traversed.)

Between Selkirk and Livingstone, woodland and prairie generally alternate for the first 45 miles from the Red River. Some wet soil, however, is met with in this stretch—in one instance, running into a bog three miles across, but drainage is not difficult, as there is a good eastern fall. For the succeeding 50 miles, the country is no so low, being elevated about forty feet above the level of Lake Manitoba. For the most part, it is wooded with scrubby oaks and good sized poplars. Frequent patches of wet land make their appearance, but it is capable of being drained by ditching, and converted into meadow land.

For about twelve miles, up to the Narrows of Lake Manitoba, the land is generally low, in some spots being but little above the high water of the lake.

After passing the "Narrows," the land continues low for some fifteen miles, but throughout the remaining 150 miles, till Livingstone is reached, the natural drainage is excellent, if we except the immediate neighbourhood of Lake Winnipegoosis. In the low country, a number of muskegs will have to be crossed, but they are reported to have firm clay bottoms, and to be, generally, not difficult of drainage.

All along the lengthy section, between the lake district and Livingstone, the soil is, generally speaking, productive; a description peculiarly applicable to the Swan River locality, some sixty miles in length, by about twenty miles broad, where the soil is exceedingly rich.

(The Timber Supply.)

With regard to timber, well-sized poplars are abundant everywhere. On the fifty miles of the route, east of Livingstone, white spruce trees of excellent quality were found, with a diameter of $2\frac{1}{2}$ feet; some reaching $3\frac{1}{2}$ feet. On the Duck Mountains, a magnificent growth of this timber is reported, much of which is within easy reach of the line. A sprinkling of tamarac is also met in some places.

The presence of timber in the district described is important. It must prove invaluable for construction purposes in the extensive prairies at no distant date.*

About fifty miles east from Livingstone, the line passes through an abundant supply of gravel, suitable for ballast.

(Navigation of Lakes and Rivers.)

During the season, a survey was made between Lakes Winnipegoosis and Manitoba, with the view of connecting the two waters. Other surveys of a similar kind were made at points on the Saskatchewan, having in view the improvement of the navigation.

(Boring Operations.)

Boring operations in connection with the question of water supply were commenced, but much progress was not made.

(Telegraph to Edmonton.)

It was deemed important to erect a telegraph along the railway route, so soon as the line should be determined. Tenders were received in July, and in October, contracts were entered into for constructing a telegraph line from Red River to Edmonton.

(Location Survey, Selkirk to Livingstone.)

It being designed that the telegraph should be placed on the precise line of the railway and its general route having now become established between Selkirk, on Red River, and Livingstone, near Fort Pelly, a location survey became necessary. Accordingly, before the season closed, the location was commenced between Selkirk, and Livingstone, the surveying parties remaining in the field, and carrying on the work during winter.

* *Vide* Appendix L, page 185. Report by Granville C. Cunningham.

In the Fifth Year.

1875.

The location surveys were carried on with so much determination and vigour, that, notwithstanding the distance, fully 270 miles, and the inclemency of the weather, together with inadequacy of shelter, the survey of the whole section from Livingstone to Selkirk was completed before the arrival of spring.

(Exploring and Locating West of Livingstone.)

It became equally necessary to prepare for telegraph construction on the still onger section from Livingstone to Edmonton, and thence to the western limit of the central region.

Accordingly, in March, arrangements were made for carrying on the survey, and during the whole season, efficient exploring and locating parties were actively engaged between Livingstone and Yellow Head Pass, the distance being about 775 miles. A detailed account of these operations will be found in the Appendix. *

Commencing at Livingstone, a reconnoitering party advanced in a westerly direction along the general route, which from previous information, it was thought advisable to examine more thoroughly. The main survey party followed, receiving suggestions and directions from time to time from the exploring party in advance, and were thus enabled to carry on the work of determining the line with rapidity.

In a densely wooded country, it is necessary to have the line staked out with tolerable accuracy, in advance of telegraph construction, on account of the necessity for clearing. In a prairie or open country, it is not so important, but it is desirable to have the telegraph erected along the general route of the railway, and, where practicable, on the precise line.

(The Atlantic and Pacific Surveys Connected.)

The course of proceeding adopted in the open country, admitted the determination of the line with sufficient precision, and favoured the rapid execution of the

* Vide Appendix M, page 189. Progress Report by H. A. F. Macleod.

work. By the 13th November, a continuous exploratory survey had been made from Livingstone, west, to Root River,—a tributary of the Athabasca—the distance measuring 629 miles. Some portions of the line thus surveyed were not perfectly satisfactory, and required revision, but the work accomplished served the immediate purpose, in connection with the construction of the telegraph, and is, in every way, of great value. It formed the connecting link in the chain of exact instrumental measurements from the Atlantic on the one side and the Pacific on the other, and tested the accuracy of the levels which had so laboriously been carried mile by mile from both oceans.

(Unsuccessful Exploration.)

During the year, a volume was published giving an account of the travels of the Earl of Southesk, some 15 years previously, in a portion of the Rocky Mountains. Some of the chapters of this book, and especially the sketch maps it contained, led to the hope that a more direct route might be found from the Yellow Head Pass to Edmonton, than any yet known. Accordingly, instructions were given to test the question by a thorough exploration, and, if expectations were realized, to follow the exploration by an exploratory survey.

It was considered important to have the examination made without delay, so that the overland telegraph should be carried by the best route.

In the appendix will be found a detailed account of this exploration.* It failed in its immediate object, but it established that the line previously surveyed, from the pass through the mountains, by the Athabasca to Root River, could be amended.

(Location West of Edmonton.)

All doubts being set at rest as to the proper course to be followed, the location of the line through the wooded country to the west of Edmonton, was deemed expedient, so that the telegraph might be proceeded with.

(The Timber Supply.)

The surveys this year showed that a larger tract of country is covered with woods than was previously believed. It was generally conceived that the country on the south side of the Saskatchewan was an almost treeless prairie. The

* *Vide* Appendix M, page 193. Exploration of Maligne Valley, &c , by H. A. F. Macleod.

engineering parties, however, found a great deal of timber; fully one half of the line surveyed from Livingstone to Edmonton passing through woodland. Poplar is almost the only description of wood found. It is closer grained than that seen in Ontario. When dry, it makes very good fuel, resembling in quality soft maple. West of Edmonton to the mountains, the country is almost wholly wooded, some groves of very fine white spruce being found. As the mountains are approached, the poplars decrease in number, while increasing in size. In this district, scrub or pitch pine begins to appear somewhat plentifully, and among the mountains, pine and spruce are the only timber met with. North-east of Carleton, very good white spruce is found.

(Coal.)

Beds of coal crop out on or near the railway line, where it crosses some of the rivers, noticeably the north Saskatchewan and the Pembina; further to the west also, on the McLeod, and at Coal Creek near the entrance to Jasper Valley. The bed at the Pembina crossing is 20 feet thick.

(Average Character of Works.)

Though some portions of the country traversed by this year's survey are hilly and somewhat broken, its general character is such that the average works of construction, will be light. More favourable crossings of the larger rivers have been found than were anticipated.

The construction of the telegraph made considerable progress. Before the close of the year, the posts were erected and the wire placed in position for 535 miles, but the clearing was not completed for that distance.

In the Sixth Year.

1876.

The work this year commenced with the placing of two locating parties between the North Saskatchewan, not far from Edmonton, and the extreme western boundary of the Central Region. This work, like that of the previous winter, was carried on with difficulty on account of the severity of the weather,—the temperature frequently ranging 40° below zero,—and from the distance from settlements where supplies and shelter could be secured. Notwithstanding all drawbacks, operations were vigorously prosecuted, and although some members of the staff suffered from exposure, a great deal of work was satisfactorily accomplished.

(Surveys East and West of Edmonton.)

During the winter and following summer of this year, the explorations and surveys were continued for the purpose of effecting improvements in the line previously laid down, east and west of Edmonton. The examinations to the east were carried on chiefly in the neighbourhood of the Willow Hills, along Battle River and at Buffalo Coulé, where the endeavour was made to avoid difficult ground and heavy work. West of Edmonton, new exploratory surveys were made between the rivers McLeod and Athabasca, and a line, more favourable than that found in the first survey, was obtained.

From the point reached on the Athabasca, the exploratory survey was extended up the valley of that river to the mouth of the Assiniboine, not far from Jasper House.

(Location Surveys.)

Location surveys were made from opposite Edmonton to the River McLeod, 150 miles; also from the mouth of the Assiniboine, up the Jasper Valley, to the entrance of the Caledonia Valley, 20 miles. The whole line, therefore, through the wooded country, on the eastern base of the mountains, is now practically determined and set out, and there is nothing to prevent the telegraph contractor proceeding with his work. The distance from Edmonton to Yellow Head Pass is nearly 260 miles. The surveys and re-surveys of 1876 covered the whole length. A trial location embraced 160 miles of the distance.*

(Telegraph in operation to Edmonton.)

The work of erecting the telegraph through the Prairie Region proceeded rapidly. Before the summer was over, the wire was in position to a point on the railway line some 20 miles south of Fort Edmonton.

THE WORK ACCOMPLISHED IN THE PRAIRIE REGION.

The examinations in the Prairie Region have established satisfactory results.

We are able to avoid the serious difficulties looked for in crossing the large rivers which are met with in the vast plains of the interior, and which lie in channels generally wide and deep.

(Bridging.)

There are indeed comparatively but few bridges of marked extent and cost required in this location, comprising 1,043 miles.

* *Vide* Appendix Y, page 337, Report on Surveys in 1876 by H. A. F. MacLeod.

The following list sets forth the more prominent structures claiming special consideration. The dimensions given are open to revision.

Red River.......................	4 spans of	200 feet;	height,	42 feet.
River South Saskatchewan...	5 "	200	"	90 "
Battle River.....................	4 "	100	"	60 "
River North Saskatchewan...	5 "	200	"	110 "
River Pembina.................	3 "	200	"	90 "
River McLeod..................	3 "	100	"	80 "
River Athabasca................	3 "	200	"	55 "
(Mountain) Assiniboine......	3 "	200	"	20 "
Snaring River....................	2 "	200	"	15 "

There will also be required probably 30 single spans, ranging from 100 feet to 60 feet, together with a considerable number of smaller openings for streams.

Several deep ravines, almost dry or with insignificant streams, have also to be crossed either by embankments or viaducts. Two of these call for heavy works. The Grizzly Bear Coulé, 668 miles west of Selkirk, has a depth of 160 feet, and a width of about 1,400 feet. Buffalo Coulé, 690 miles west of Selkirk, is 100 feet deep by about 1,400 feet wide. There are three other ravines, averaging 2,300 feet wide by 45 feet in depth.

These are the chief points which appear to necessitate heavy works. Thus the bridging, when averaged over the whole distance, will be remarkably small. The other works of construction will be comparatively light.

(Gradients.)

The gradients and alignment will nowhere be less favourable than on the railways now in operation in the older Provinces. The maximum gradient between the Yellow Head Pass and Selkirk will be 52·80 feet per mile. Up to a point 468 miles west of Red River no gradient ascending eastwards in the probable direction of heavy traffic need exceed 26·50 feet per mile.

(The Telegraph.)

The line is located throughout the entire length of the Region with sufficient accuracy to admit of the construction of the overland telegraph. Telegraphic

communication has been established from Winnipeg on the Red River to the longitude of Edmonton, a distance of 807 miles. There remain only 256 miles to reach the Yellow Head Pass.

(Navigable Branch Lines.)

The line established intersects the navigation of Lakes Winnipeg, Manitoba, and Winnipegoosis, Red River and the South and North Rivers Saskatchewan. These water channels will furnish connecting lines of travel, to be traversed by suitably constructed steamers; the total length of these water communications being fully 2,000 miles.* They will greatly aid both in the construction of the Railway and in the settlement of the country; and hereafter will doubtless furnish valuable contributions to the traffic of the Line.

(Wood, Coal and Iron.)

The line runs through the wooded groves contiguous to the prairie sections. The advantage of this feature in the location is obvious. The timber will become of great value, as it is available for construction and for the purpose of fuel, as settlement calls for it.

The line, where it crosses several of the rivers, especially in the western half of the Region, intersects outcrops of mineral fuel.

The presence of coal needs no argument to sustain the importance of the fact. Iron ore is also found at accessible distances from the Railway; and these two minerals give promise of the establishment of future centres of industry along the line.

Operations in the Woodland Region.

In the First Year.

1871.

At the beginning of the survey, a large extent of this Region was but little less strange than the Mountain Region. No civilized man, so far as known, had ever passed from the valley of the Upper Ottawa through the intervening wilderness to Lake Superior. The country east and west of Lake Nepigon was all but a *terra incognita.*

* The Saskatchewan, including for half the season, 200 miles of the south branch, say......	1,400 miles.
Lakes Manitoba, Winnipegoosis, and Winnipeg, say........	500 "
Red River to the U. S. Boundary Line, say........	100 "
	2,000 miles.

It is true that the chain of lakes and streams from Thunder Bay to Lake of the Woods and Fort Garry, known as the Dawson Route, had been travelled, but this route was circuitous and much out of the way of a direct railway line.

(External features forbidding.)

All accounts of the country to be traversed by the railway, at least such portions of it as were, in any way, known, were unfavourable. The southern margin of this region extends for some 600 miles along Lakes Huron and Superior, where the eye rests upon only a continuous frontier of rugged rocky hills, and on the more northern lake, they assume the form of bold bluffs of great height rising from the water's edge The surface is generally wooded. In many places dense thickets are met. Judging from an exterior so rough, and general features so forbidding, the Region was deemed by many impracticable for railway construction.

(Preliminary Work, Ottawa to Red River.)

The first step was to pierce the interior by a chain of connected explorations and actual measurements, both of distance and height.

These operations were commenced at Mattawa, a point on the River Ottawa, in the latitude of Lake Nipissing, to which locality exact surveys and levels had, some years previously, been carried from tide water to determine the construction requirements of an Ottawa ship canal. Strong parties, eleven in number, were detailed to carry on the required operations from Mattawa, west, to Red River, a distance exceeding 1,200 miles.

Great efforts were made to have these surveys connected within the year, but the vast distances which intervened through an entirely roadless, and, in some places, exceedingly rough country, made it late in the summer before portions of the survey could be actually commenced. The difficulties in the way of keeping the parties furnished with supplies, was also great.

(Winter Surveys.)

Only two of the eleven parties finished the work assigned to them by the end of the season, and it became necessary to carry on operations during the winter following.

(Exploration to James' Bay.)

During the summer and autumn, examinations were made in other directions.

The River Ottawa was explored to its most northern source, and the country along the Rivers Abittibi and Moose, flowing into Hudson's Bay, was traversed.

(Survey East of Sault Ste. Marie.)

An Exploratory survey was made along the northern coast of the Georgian Bay, 100 miles east from Sault St. Marie, and an exploration was made in the same direction as far as French River.

The object was to ascertain the practicability of bridging the outlet of Lake Superior, and carrying a "through" line of railway from that point east through Canada and in a westerly direction through United States territory.

In the Second Year.

1872.

The explorations were carried on during the whole winter, and by the spring it was found that the formidable difficulties which had presented themselves in tracing the line south of Lake Nepigon, might be avoided by passing the lake to the north.

Line North of Lake Nepigon.)

Exploratory surveys were accordingly made in that direction, and before the season closed, it was established that the railway could be constructed from the River Ottawa to Red River, *viá* the northern side of Lake Nepigon, and that neither the work nor the gradients would be exceptionally heavy.

With the main line carried to the north of Lake Nepigon, a branch to Lake Superior would be necessary. Two lines for the branch were examined, one to Thunder Bay, the other to Nepigon Bay.

In the Third Year.

1873.

Although the practicability of constructing the railway through the Woodland Region had been established by carrying the line to the north of Lake Nepigon, the fact that this route made a considerable detour from the direct course, and called for the construction of a long branch to Lake Superior, suggested that renewed efforts should be made to obtain a line south of Lake Nepigon. The whole season was spent in this work.

(Renewed Efforts South of Lake Nepigon.)

The surveys were carried on from the northern end of Long Lake, south-west to the River Nepigon. The country was thoroughly examined from the River Nepigon towards the west, and in a north-westerly line to Black Sturgeon Lake; thence exploratory surveys were made on several lines, in the direction of the height of land between Nepigon basin and the basin of the Lake of the Woods.

The ground proved exceedingly broken, and many difficulties were met with. But a practicable route was eventually traced, by which the main line from Ottawa to Red River could be brought to the navigable waters of Lake Superior, at the head of Lake Helen; some improvements being called for to render that portion of the River Nepigon, between Lake Helen and Nepigon Bay, navigable.

(Survey from Thunder Bay.)

Another exploratory survey was undertaken from Thunder Bay, running in a general course about mid-way between the lines previously examined. All the surveys this year, west from Nepigon and Thunder Bay, pointed to a convergence east of the outlet of Lake of the Woods, at Rat Portage.

The north-westerly survey from Thunder Bay being incomplete when navigation closed, it was carried on during the winter months.

(Between Lakes Nipissing and Superior.)

Explorations were also made during this year in the district lying between the River Ottawa and Lake Superior. These explorations were begun at Lake Nipissing, and extended in a north-westerly direction from that lake, through the interior, to the east branch of Moose River, which flows to the north, and ultimately discharges into James Bay.

The results were satisfactory, a comparatively direct and favourable route for the railway was discovered by the valley of the Sturgeon River, to a point of intersection with the line previously found practicable between the River Montreal, a branch of the Ottawa, and the north end of Long Lake.

Detailed descriptions of the surveys, as well as information of a general character respecting the country traversed, will be found in previous reports.*

* *Vide* Report, January, 1874, p. 27 to 34 ; p. 199 to 213.

In the Fourth Year.

1874.

In March, 1874, two parties proceeded to the mouths of French River, for the purpose of surveying the several outlets.

(The Georgian Bay Branch.)

Taking advantage of the ice, they were able to effect soundings over an area of 10½ square miles. These investigations showed the comparative superiority of the middle outlet for the purpose of a harbour for the Georgian Bay branch.

In the summer of the same year, alternative routes for the Georgian Bay branch were examined. Two lines were explored: the one starting from the Canada Central Railway at Carleton Place, and terminating at Parry Sound on the Georgian Bay; the other commencing at Renfrew, (also on the Canada Central Railway) and ending at the middle outlet of French River. The latter route was ultimately adopted.

(Route between Nipissing and Nepigon.)

Examinations were undertaken this year for the purpose of determining the practicability of carrying the railway in a direct line from Lake Nipissing *viâ* the River Pic and the coast of Lake Superior to Nepigon Bay. The exploration from Lake Nipissing to the mouth of the River Pic proved satisfactory. It was found that nearly the whole of the country through which the line is projected in this section offers a fair site for the railway. Abundance of timber, and a proportion of good soil is reported.* On Lake Superior, however, the country adjacent to the coast was found to be of an extremely rough and broken character; precipitous granite mountains, intersected by valleys impracticable for railway construction, rising in all directions with elevations varying from 500 to 1,000 feet above the level of the lake. A route had, consequently, to be adopted, in the main, following the shore. It is 117 miles in length, and for 30 miles only at any considerable distance from the margin of the lake.†

(Character of Coast Route, Pic to Nepigon)

This route is not without difficulties peculiar to itself. The coast is generally bold and rugged, and in many instances the line has to follow the shores of indenting bays; consequently, numerous tunnels and sharp curves become a matter of necessity.

* *Vide* Appendix N, page 204, Report on Exploration, by W. A. Austin.

† *Vide* Appendix O, page 206, Report on Survey, by T. Jefferson Thompson.

The aggregate length of the tunnels will amount to $7\frac{1}{2}$ miles. The grades, however, are for the most part easy. On the whole line, only six bridges, the largest 230 feet span, would be required, with an aggregate length of less than 800 feet. The excavations would not be excessive, but the formation is chiefly of rock.

The tunnelling referred to consists of many short lengths, and it is not improbable that it may be reduced on accurate location surveys being made.

The practicability of constructing a line by this route has been, accordingly, ascertained. The line would be much curved, and, for some part of its length, costly, but it would shorten the distance between extreme points.

(Lake Superior to Lake Nepigon.)

It was deemed advisable to ascertain the practicability of connecting the navigation of Lake Superior with that of Lake Nepigon, and a survey was, accordingly, made. The distance is about 15 miles. The line of survey followed, for about 11 miles, the course of a stream which flows into Lake Helen. At the source of this stream there is a lake of no great size, and separated from a second small lake, in length $2\frac{1}{2}$ miles, by a ridge of land These lakes are about 1,500 feet apart. The survey was sufficient to establish the fact that a railway could, without difficulty, be constructed from Lake Nepigon to Lake Helen, and that it would be possible to extend the navigation of Lake Superior to the head of Lake Nepigon. Works of considerable magnitude would, however, be required, including the construction of locks to overcome a rise of 250 feet from one lake to the other.

(Location Survey, Thunder Bay to Shebandowan.)

In the autumn, the location of the line between Thunder Bay and Lake Shebandowan, a distance of 45 miles, was commenced, and considerable progress was made by the end of the year.

(Red River to Rat Portage.)

During the season, a favourable crossing point for the railway at Red River was selected, and a line surveyed in an easterly direction to Rat Portage. The line was direct, and the distance from Red River to Cross Lake, 77 miles, was favourable, with light work. The remaining 37 miles, between Cross Lake and Rat Portage, passed over a rocky and broken country, involving excavations and embankments, as well as bridging of a heavy character.

(Rat Portage to Sturgeon Falls.)

By the end of the winter, 1873-74, explorations, with the view of finding a direct route from Rat Portage in a south-easterly direction towards Sturgeon Falls, or some other point on the navigable reaches flowing into Rainy Lake, were completed. The investigation proved unsuccessful; no practicable route being discovered. A good line was found, however, running for 200 miles east from Rat Portage, *viâ* Lakes Eagle and Wabigoon.

(The Lake District, East of Lake of the Woods.)

Extensive explorations were made of the water channels lying between Lake Wabigoon, Lake of the Woods, Lac des Mille Lacs and Lake Nepigon, for the purpose of ascertaining how far the natural water communications could be made available as auxiliaries to the Railway during construction.

(Improving the Dawson Route.)

In the autumn of 1874, a survey was made of the various rapids and portages between the Lake of the Woods and Lake Shebandowan, to ascertain the best means of improving the communications on the "Dawson Route." Twelve portages and some minor rapids were examined. The total length of works required would be 14 miles, while the sum of the differences of levels between contiguous points is about 465 feet. The improvements would probably consist of canals and locks in some places, and tramways in others.*

(The Pembina Branch.)

It was deemed advisable to proceed this year with the construction of the Pembina Branch. Accordingly, that portion extending from the southern boundary of Manitoba, north, to a point opposite the town of Winnipeg, was located and placed under contract.

The contract was entered into on August 31st, 1874, and the work was vigorously prosecuted during the remainder of the season.

In the Fifth Year.

1875.

With a view of determining the extent to which the lakes between Thunder Bay and Red River could be made navigable and brought into connection with the

* *Vide* Appendix P, page 211, Report on Survey of Portages by Henry I. Mortimer

railway, engineering parties were sent, early in the winter, to make exploratory surveys.

1st. Between a point at the head of navigation of Rainy Lake, near Sturgeon Falls and Lake Windigoostigan, to ascertain the shortest and best line for a railway between these two navigable water stretches.

2nd. Between Lakes Windigoostigan and Shebandowan, to ascertain the practicability of bringing these and the intervening Lakes Kashaboie and Lac des Mille Lacs to the same level, and so obtaining an unbroken navigation.

3rd. A survey from Sturgeon Falls, in the direction of Rat Portage, to establish the practicability of constructing a railway.

4th. From the western end of Lake Windigoostigan to the eastern end of Lake Shebandowan, to ascertain if a railway could be built on a moderately direct course between these extreme points, in the event of a canal proving impracticable.

(Line by Sturgeon Falls to Rat Portage.)

The second and third surveys did not result satisfactorily. The cost of rendering the navigation continuous between Lakes Shebandowan and Windigoostigan would be very heavy, much greater indeed than any immediate advantage would justify. It was also established, that, with the exception of about 16 miles west from Sturgeon Falls, the line to Rat Portage would pass through an extremely broken country, and that it would not be practicable to construct a railway through it at moderate cost.

It was found that a good line was obtainable from Sturgeon Falls to an intersection with the line surveyed to Thunder Bay at the eastern end of Lake Shebandowan. An examination was made north from Sturgeon Falls, with the view of avoiding the objectionable ground on the eastern side of Lake of the Woods. The obstacles met with rendered the detour so great as to compel the abandonment of the project.

(Line Via Wabigoon.)

Other surveys established that a good line at comparatively moderate cost could be had in a direct course from Eagle Lake *viâ* Wabigoon River to Lac des Mille Lacs, and thence to Thunder Bay, intersecting the line of Contract No. 13 at Sunshine Creek, 15 miles east from the eastern end of Lake Shebandowan.

In the meantime, the work under Contract No. 13, for grading the road-bed from Shebandowan to Thunder Bay, was stopped on the 15 mile section, west of Sunshine Creek.

(Sault Ste. Marie to River Pic.)

An exploration was made this year from Sault St. Marie, along the east side of Lake Superior, to the River Pic, with the view of ascertaining how far the country would admit of railway construction. The results were not sufficiently satisfactory to justify further expenditure in this direction.

(Lake of the Woods to Cross Lake.)

In connection with the scheme of utilizing the navigable water stretches between Lake Superior and the prairie region, it was deemed advisable to ascertain by survey how far it would be practicable, at moderate outlay, to extend the navigation of Lake of the Woods in a westerly direction. Accordingly, an exploratory survey was made. The project, which at first promised to be feasible, was ultimately abandoned on account of the difficulties to be overcome.

Contracts for Work and Material.

(Telegraph, Red River to Lake Superior.)

As the erection of a telegraph along the railway line was considered of paramount importance, a contract was entered into, February 9th, 1875, for the work of clearing, placing the poles and hanging the wire, &c. It was intended that the work should be commenced simultaneously at the extreme points, Red River and Thunder Bay, and thence be carried onwards to the interior, as the surveys were completed and the contracts for grading and bridging let.

(Purchase of Rails.)

During the summer and autumn of 1874, an unprecedented fall in the price of steel rails occurred. It was considered prudent to secure a stock before prices again rose, a result predicted by every one in the trade. Accordingly, tenders for the supply of a limited quantity were invited, and at the beginning of the year, contracts for the supply of 50,000 tons, with the necessary fastenings, were made,

(Grading and Bridging.)

Tenders were invited for the works connected with the construction of the road-bed, north-west from Fort William, on Lake Superior to Lake Shebandowan, 45 miles. A contract was entered into on April 3rd, 1875. This section was subsequently reduced to the portion $32\frac{1}{2}$ miles long, from Fort William to Sunshine Creek. On the same date, a contract was made for the grading and bridging, from Selkirk, on Red River, 77 miles east to Cross Lake.

(Sundry Supplies and Works.)

During this year, other agreements were made for furnishing railway sleepers, transportation of rails and the erection of houses at points on the line north-west from Lake Superior and east from Red River. These houses are intended ultimately for station buildings. In the meantime, they are to be utilized, during the construction of the works, as offices and dwellings.

In the Sixth Year.

1876.

The explorations this year consisted of an examination of the country, lying to the south-east of the River Pic, in as direct a course as practicable towards French River; and from French River, in a north-westerly direction, towards the mouth of the River Pic. The exploration was incomplete when the open season closed; about 40 miles remaining to be examined. Much of the country was found to be rocky and broken, interspersed with lakes and swamps.

(Route Via Dog Lake to Nepigon Bay.)

Another exploration was made from the neighbourhood of Lac des Mille Lacs, east, *viâ* Dog Lake to Nepigon Bay. A practical route, without excessively heavy works, is reported, establishing the fact that the trunk line from the prairie region to the eastern terminus in Ontario, may, in the future, be carried in a direct course, without making a detour to Thunder Bay. The line now under construction to Fort William, will then constitute a short branch, from the main line, to the navigation of Lake Superior.

(The Georgian Bay Branch.)

A trial location survey has been made from French River, at Contin's Bay, east to the point established by Statute as the eastern terminus.

(Location, Lake Superior to Red River.)

A trial location survey has been completed between the sections which were under contract and construction, at the beginning of the year, east from Selkirk at the west, and north-west from Fort William, at the east. The intervening distance is found to be 300½ miles, which, with the 13th contract, 32½ miles, and the 14th contract, 77 miles, makes the whole distance from Fort William to Selkirk 410 miles. With the exception of 70 miles, which distance includes what is known as the 15th contract, the works of construction will not be heavy. The alignment and gradients will be favourable. The maximum gradients ascending towards the west will be 52·8 per mile, and it is expected that a careful revision of the location will effect the reduction of all the gradients ascending towards Lake Superior, to the low rate of 0.5 per 100, or 26.4 feet per mile as a maximum.

(Contracts of Work.—Tracklaying, &c., Fort William to English River.)

During the winter, tenders were invited for the grading and bridging required on the section west from the 13th contract, viz.: from Sunshine Creek to English River, 80 miles, and for track-laying and ballasting from Fort William over the 13th contract to Sunshine Creek, and thence to English River, a total distance from Fort William of 113 miles. The contract for the work was entered into on the 7th June, 1876. During the year, these works have been pushed on vigorously; the rails have been laid for a distance of 24 miles, north-west from Fort William.

(Engine House at Fort William.)

A contract for the erection of a ten-stall engine house at Fort William was given out on July 11th. Considerable progress has been made in the work.

(Transportation of Rails, Rolling Stock, &c.)

Agreements have been made for the transportation of engines and cars to Manitoba, as well as for the purchase of spikes, bolts and nuts, and for the transportation of rails and other material.

(Contracts for Grading, Cross Lake to Keewatin.)

Since the year closed, a contract has been entered into for the grading and bridging between Cross Lake and Keewatin at the outlet of Lake of the Woods, as

well as for the track-laying and ballasting from Selkirk to Keewatin. The contract is dated 9th January, 1877.

A list and description of all contracts entered into, together with an account of the expenditure on construction, and the general specification under which the principal works are being executed, will be found in the Appendix.*

The Work Accomplished in the Woodland Region.

The topographical features and the adaptability to railway purposes of a country covered with woods, and imperfectly known, can only be ascertained by patient and persistent efforts. The view is much obstructed by the growth which covers the surface. The axe must generally be used to admit of observations being made for even a few hundred feet. The way must be felt little by little.

The Woodland Region is covered by dense forests throughout its length of more than a thousand miles from east to west, and in its breadth from the Great Lakes north to Arctic waters.

It is entirely without roads of any description; the examination has, consequently, proved difficult and tedious. Exploratory lines have been carried through the forest in every direction where the determination of facts suggested their necessity. Thus, at great labour, we have acquired valuable information, and the results may be viewed with satisfaction.

The successive operations in each year have been described; the results may now be summarised.

An extremely favourable line has been established from Selkirk, on Red River, in a course as nearly direct as possible, to the nearest navigable waters of Lake Superior at Fort William.

A route has been traced by which the line from Selkirk to Lake Superior may be extended to connect with the railway system of the country, without making any great detour. The extension will leave the line from Selkirk to Fort William, a short

* *Vide* Appendix Zc, page 383, Expenditure on Construction, Contracts, Specification, etc.

distance from the latter place, and passing in an easterly direction by the mouth of the River Nepigon, will keep along the coast of Lake Superior to the River Pic; thence, leaving the coast, it will cross the country to Lake Nipissing.

The distance from Selkirk to Fort William is 410 miles. A contract for clearing the line for this distance, and the erection of a telegraph is in force. The work of grading, bridging and tracklaying for 226 miles of this distance is in progress.

The first locomotive engine was landed at Fort William in August last. The rails have since been laid for 24 miles inland. The telegraph is in operation 45 miles farther, and buildings for the purposes of the railway are in course of erection at various points along the line between Lake Superior and Red River.

The Pembina branch is about three-fourths graded, ready for tracklaying, and a large quantity of rails has been delivered. The total length is about 83 miles.

It may be stated that in the location of the section between Red River and Lake Superior, special regard has been had to securing a line capable of conveying the products of the prairie country to Eastern markets at the lowest possible rates.

GENERAL OBSERVATIONS.

I have explained that from the continental divide at Yellow Head Pass east, to Lake Superior, the route of the railway is practically established, and for the greater portion of this distance a telegraph is erected along the line.

To the west of the Yellow Head Pass, however, the selection of a route to the Coast has not yet been made. This subject claims careful consideration.

The Route through British Columbia.

Several important considerations enter into the question of a choice of route amongst which may be enumerated:

1. Engineering features of line.

    (1.) Length.

    (2.) Difficulties of construction.

    (3.) Cost.

    (4.) Facilities for cheap transportation.

    (5.) Cost of maintaining and operating.

2. Traffic.

(1.) Local resources.

(2.) Population and local advantages.

(3.) Through traffic.

(4.) The Terminus.

In the Appendix will be found a description of the routes which have been more carefully examined. The engineering features of each are set forth as fully as circumstances warrant. Tables of gradients and alignment can only be furnished in the cases where trial location surveys have been made.*

Length of Lines.

The length of the ten different routes projected from the Yellow Head Pass to the Coast, is as follows:

					Miles.	
Route No.	1.	Terminating at	Port Moody,	Burrard Inlet.........	461	Measured†
do	2.	do	do	do	493	"
do	3.	do	Howe Sound	....	464	"
do	4.	do	Waddington Harbour,	Bute Inlet.	550	"
do	6.	do	do	do .	546	"
do	7.	do	North Bentinck Arm	....	480	Estimated.
do	8.	do	Kamsquot,	Dean Inlet	488	Measured.
do	9.	do	do	do	506	"
do	10.	do	Triumph Bay,	Gardner Inlet.......	560	Estimated.
do	11.	do	Port Essington	....		Uncertain.

Comparative Cost.

It would undoubtedly be desirable for the purpose of comparison, to have reasonably correct estimates of the probable cost of each route, but this result is unattainable without regular location surveys.

---

* *Vide* Appendix T, page 254, Report, by Marcus Smith.

† 36 miles of this distance estimated.

We have a location survey of one line from the coast to Yellow Head Pass. We have exploratory surveys of three other lines and fragmentary trial location surveys of difficult portions on each of them. But the data are insufficient, except on one line (No. 6), to admit of estimates of quantities being made with any approach to accuracy.

(Data insufficient for estimating cost.)

It is an exceedingly difficult matter, even with data sufficient to deduce the actual quantities of work, to form an estimate of cost, at all reliable, owing in part to the uncertainty of the price of labour. It is impossible to say what wages it may be necessary to pay. The price of labour on the Pacific coast has, of late years, been much higher than on the Atlantic Coast; and it is not possible to foretell what its range may be in future years. The value of labour enters so largely into the cost of a railway that any estimates of probable expense are conjectural, unless the price of that labour be established.

(Standard of value.)

It is, nevertheless, possible to form a comparative estimate by taking, as a standard, the prices which have obtained on other public works recently completed.

The Intercolonial Railway will, in this respect, be taken as the standard, and the estimates will be based on the cost of labour during the construction of that work. A percentage may be added, as individual judgment may dictate, equivalent to any supposed advance of price, which may affect the western section of the Pacific line.

(Estimated cost of Route No. 6.)

According to this standard of the value of labour, the probable cost of the Route No. 6 can be approximately estimated.

The quantities on the route on which a trial location has been made, from Yellow Head Pass to Waddington Harbour (No. 6), have been computed, and the standard of value has been applied to determine the cost of the works.

The schedule of the gross quantities of rock and earth excavation, of tunnelling, masonry, bridging, etc., is given in full in the Appendix. It includes everything deemed necessary to complete the grading of the railway, with solid embankments,

iron bridges, and, generally, with durable structures equal in point of character to those on the Intercolonial line.*

Adding the cost of ballasting, permanent way, rolling stock, stations, shops, snow sheds and fences, indeed all the supplemental expense indispensible to the construction and completion of a line similarly equipped, and equal in efficiency and permanency to the Intercolonial Railway, and basing the calculations of cost on precisely the same data, the same value of material, and the same average value of skilled and unskilled labour as obtained on that work, the railway from Yellow Head Pass to Bute Inlet, No. 6, may be estimated to cost $33,000,000.

(Estimate of other Routes.)

The cost, however, of one line is of little use in making a comparison of routes; but as estimates, even if only rough approximations, of the other lines, are demanded, it becomes expedient to adopt some method by which the information may be obtained. The only way in which estimates can be formed of the other lines, is by a study of the profiles and the other data of the surveys; by comparing the various portions of each line, the one with the other, and with a common standard; and by applying the rule of proportion to sections which correspond in general character, but are different in length.

Some difficulty has been experienced in making this comparison, owing to many important documents and memoranda connected with the survey having been destroyed by the fire of 1874, when the offices of the survey were burnt. It has not been possible to replace many of the plans and papers which were lost; consequently the precise information then recorded, which has not since been reproduced, is not now available. Every care has, however, been taken with the data at command to arrive at as accurate results as possible.

A comparison of the estimates which have been formed shows that Route No. 2, from Yellow Head Pass to Burrard Inlet may, with a judiciously selected location, be established and completed for about $2,000,000 more than Route No. 6, terminating at Waddington Harbour. No. 2 has a much greater length of very heavy works, but the extreme length from Yellow Head to tide water is some 53 miles shorter, and thus the common mileage charges, embracing permanent way, rolling stock, and various other services, form a reduction in the cost of the line to Burrard Inlet.

* *Vide* Appendix Q, page 217, Schedule of quantities on Line No. 6.

Route No. 3, ending at Howe's Sound, although 94 miles shorter than Route No. 6, is estimated, nevertheless, to cost $6,000,000 more.

Route No. 4, which crosses from the Thompson by Lac la Hache and the Chillicotin Plains to Waddington Harbour, is estimated to cost $5,000,000 more than Route No. 6, terminating at the same point.

Route No. 8, ending at Dean Inlet, appears to be the least costly of the several lines of which estimates are furnished. The estimate of the cost of this route is $4,000,000 less than Route No. 6. Its length is nearly the same as that of Route No. 2.

In the estimates, similar mileage allowances for rails, rolling stock, stations, and other necessary general service, have, in each case, been made.

Exact location surveys would, in all probability, reduce the work estimated on several of these routes; in some cases the reduction may be important, but with our present information, it would not be prudent to estimate the cost at much less than the sums now mentioned.

With respect to the other routes mentioned in this Report, the data in my possession are insufficient for estimates of any value to be made concerning them.

(Summary of Estimates.)

The following is a statement of the comparative cost of the five routes across the Mountain Region, deduced as above explained, the lines, in all cases, being taken from the eastern boundary of British Columbia in the Yellow Head Pass.

ROUTE No. 2.—Following the North Thompson *via* Kamloops to Lytton and by the Lower River Fraser to Port Moody, Burrard Inlet, 493 miles	$35,000,000
ROUTE No. 3—*Viâ* the North Thompson, Bonaparte Valley, Marble Canyon, Lillooett and Lake Anderson to Howe Sound 464 miles	$39,000,000
ROUTE No. 4—*Viâ* the North Thompson, Clearwater, Lake Canim, Lac la Hache, Soda Creek, Chillicotin Plains and East Homathco to Waddington Harbour, 550 miles	$38,000,000
ROUTE No. 6—Following the North Fraser to Fort George, and by the Rivers Chilacoh, Nazco and East Homathco to Waddington Harbour, Bute Inlet, 546 miles	$33,000,000

ROUTE No. 8----- *Viá* the North Fraser, Fort George, Rivers Chilacoh, Blackwater and Salmon, to Kamsquot, Dean Inlet 488 miles $29,000,000

These estimates are founded on the theory that the works are to be constructed equal in character to those of the Intercolonial Railway.

(First Cost may be Reduced.)

The amount of expenditure, however, may, in the first place, be reduced by the introduction of timber trestle-work in the place of solid earth or rock embankments, and by the use of temporary structures in place of permanent and more costly ones. Various expedients could be resorted to to limit the first expenditure, generally, by the adoption of perishable works to be replaced as they require restoration by more permanent works. By this means the first cost could be reduced, but with the prospect of ultimate increased expense.

It is found difficult to determine the extent, in each case, to which temporary structures may be admitted, and it would be impossible to make a fair comparison of the several lines unless the estimates were based on precisely the same standard. Accordingly, it is considered advisable, as has already been stated, to take the standard of the Intercolonial Railway, where solid and permanent works generally prevail.

(Leading Characteristics.)

The characteristics of a railway have much to do with its capacity for business, and the cost of maintaining and operating it. The route which will in the highest degree admit of low gradients, easy alignment, and permanently firm road bed, at the least annual outlay, is the one most capable of transporting cheaply.

In this respect, there can scarcely be a doubt as to Route No. 2, terminating at Burrard Inlet, being the best. The others, as far as they are known, would probably stand in the following order :—

2nd.................................. ....Route No. 8	terminating at	Dean Inlet.
3rd ....Route No. 9	do	do
4th .... Route No. 6	do	Bute Inlet.
5th ....Route No. 4	do	do
6th .... Route No. 1	do	Burrard Inlet.
7th...Route No. 3	do	Howe Sound.

The other routes, Nos. 10 and 11, terminating at Gardner Inlet and Port Essington, can scarcely be classified, as they are not sufficiently known. It is believed, however, that the latter, Route No. 11, would have easy ascending gradients by the valley of the River Skeena to the lake country in the interior, thence *viâ* Fort George and the Fraser to Yellow Head Pass.

Local Advantages and Resources.

The extensive territory embraced within the limits of British Columbia is great, while the population of that Province is exceedingly small. The few civilized inhabitants are chiefly resident in the south-west angle of the Province. Accordingly, the route of the greatest advantage to the present population, would terminate on the coast, at the extreme south.

(Existing Local Traffic.)

It is evident that the trade and traffic of this present population, will contribute but little towards sustaining the western section of the Railway. It is the more necessary therefore to consider where industries may be developed and traffic created. The best lands in British Columbia appear to extend between the Rocky and Cascade Mountains, and mainly exist between the 49th and 51st parallels of latitude. But they are limited in extent, and when fully developed for purposes of agriculture and stock raising, can only have a sparsely-settled pastoral and farming population.*

(Future Local Traffic.)

With the view of estimating, with some reasonable degree of probability, the localities where, in the future, industries of various kinds may be developed, the Geological Survey was instructed specially to examine different sections of the Province. Although the inquiry is far from exhausted, some progress has been made, and a Report on the economic minerals of the region is appended. †

The data collected establish the existence of great mineral wealth in British Columbia, and the opinion is expressed by the geological officers of the Government that the resources of that Province will rather surpass than fall short of the estimates given. Attention is directed to the report on this subject, and the observations, in a separate note, on agriculture and stock raising, and extent of cultivable land.

* *Vide* Appendix S, page 246, Note on Agriculture, &c., by G. M. Dawson.

† *Vide* Appendix R, page 218, Note on the economic Minerals and Mines of British Columbia, by G. M. Dawson.

Through Traffic.

The important question of traffic, especially "through traffic," calls for judgment in the selection of a terminus. It is most desirable that the railway should terminate on the coast at a harbour, which from its general excellence and geographical position, would be best calculated to accommodate the shipping of the Pacific and attract commerce from distant countries. This question has an important bearing on the choice of route. On the one hand, a favourable line, not difficult of construction, may lead to a harbour deficient in many desiderata. On the other hand, a harbour in every way desirable, may be unapproachable from the interior, or one that can only be reached by a line so unfavourable in its gradients and general character, and so enormously costly of construction as, in either case, to render the selection inexpedient.

The Harbours of British Columbia.

In the search after reliable information upon the features of the coast line of British Columbia, it was considered that the officers of Her Majesty's navy who have served on the north Pacific station must have had repeated occasion to examine that coast, and more than any other class must possess that information without which no harbour should be selected as the water terminus of the line.

(Application to the Admiralty for information.)

Accordingly, application was made, through the Colonial Office, to the Admiralty for whatever special information might be possessed respecting the seven harbours with which the railway lines have been connected, and, further, for all the known facts, of a general character, concerning other harbours and waters on the British Columbia coast.

In order to obtain the information in as concise a form as possible, I prepared a series of queries for submission to the principal naval officers who had had opportunities of examining the harbours, anchorages, channels, and currents of the coast.

These queries were accompanied by a preamble, which set forth the objects of the inquiry, viz. :—

That it had been determined to establish a railway through Canada to the Pacific Coast;

That extensive explorations had, during the past six years, been made;

That several routes, more or less practicable, had been discovered;

That it was considered of the first importance to select such a route and western terminus as would best command traffic, in order that the railway might eventually become self-sustaining, or be as little burdensome as possible;

That as no local business at all commensurate with the cost of the undertaking could, for many years, be looked for, it was the more important to give every consideration to "through trade," and to select such a route and terminus for the railway as would best attract ocean traffic, and would admit of successful competition with foreign lines.

(Replies to queries.)

The replies which have been received are given in the appendix.* The following deductions may be drawn from them:—

The proximity of the seven harbours to the Asiatic coast stands in the following order, Yokohama, in Japan, being taken as a common point.

(Distances from the Asiatic coast.)

	Miles.
Port Essington, mean distance	3,868
Triumph Bay, Gardner Inlet	3,970 3,983 4,120
Kamsquot, Dean Inlet	4,079
Bella Coola	4,080
North Bentinck Arm	4,086
English Bay, Burrard Inlet	4,336
Port Moody, do	4,356
Howe Sound	4,372
Waddington Harbour, Bute Inlet	4,470

(Length of towage.)

The harbours stand, with respect to the least distance that sailing ships would have to be towed:—

* *Vide* Appendix U, page 278, Correspondence, queries and nautical evidence respecting the harbours and waters of British Columbia.

	Mean distance.	
Port Essington	49	miles towage.
English Bay Burrard Inlet	70	"
Howe Sound, Burrard Inlet	76	"
Triumph Bay, Gardner Inlet	80	"
	90	"
	110	"
Port Moody, Burrard Inlet	90	"
Kamsquot, Dean Inlet	93	"
Bella Coola	97	"
North Bentinck Arm	100	"
Waddington Harbour, Bute Inlet,	156	"

(Advantage of Port Essington with respect to distance.)

Port Essington thus appears to be the nearest harbour to the Asiatic Coast

It is 102	miles	nearer than	Triumph Bay, Gardner Inlet.
211	"	"	Kamsquot, Dean Inlet.
468	"	"	English Bay, Burrard Inlet.
488	"	"	Port Moody, "
602	"	"	Waddington Harbour, Bute Inlet.

(Advantage of Port Essington with respect to towage.)

Port Essington requires the least towage for sailing ships, viz:

21	miles	less than	English Bay, Burrard Inlet.
27	"	"	Howe Sound.
36	"	"	Triumph Bay, Gardner Inlet.
41	"	"	Port Moody, Burrard Inlet.
44	"	"	Kamsquot, Dean Inlet.
48	"	"	Bella Coola, North Bentinck Arm.
107	"	"	Waddington Harbour, Bute Inlet.

The weight of naval evidence does not favour Port Essington, or indeed any northern harbour. It rather points to an extreme southern harbour, as the one which, on nautical considerations alone, should be selected as the terminus.

(Opinions of Vice-Admiral Cochrane.)

In reply to queries 26, 27 and 28, *Admiral Cochrane* apprehends that the navigation of all the inlets, except Burrard Inlet, would be much interfered with in the winter time by ice and snow storms, and in the summer time by fogs. He considers that the terminus should not be situated at the head, or in any part of the inlets; thus limiting the selection to Burrard Inlet, Skeena River or Metla Catlah, and some part of Milford Haven. He gives the preference to Burrard Inlet, but thinks that when the Queen Charlotte Islands are settled, the terminus may be transferred farther north.

He states that he found the temperature of the sea on the northern coast to be the same as on the southern coast of British Columbia: that the climate of the Queen Charlotte Islands, tempered by ocean currents, is mild, and that its resources of agriculture, mining and fisheries are valuable.

(Opinions of Rear Admiral Richards.)

Admiral Richards states: The farther north, the greater are the objections on account of climate, boisterous weather, fogs, etc. From a nautical point of view, he thinks English Bay, outside of Burrard Inlet, is the preferable point; next in order, Port Moody, next Howe Sound; then Bute Inlet: that all the others have great disadvantages. He does not favour the approach to the coast between Vancouver and Queen Charlotte Islands. He considers the entrance by Juan de Fuca Strait the best. The northern approach with Port Essington as a terminus comes next.

(Opinions of Vice-Admiral Farquhar.)

Admiral Farquhar thinks that there are no decided objections, of a climatic nature to Burrard Inlet, Howe Sound, or Bute Inlet, but undoubtedly the climate becomes more severe farther north. He favours Burrard Inlet, on account of its being the southernmost harbour, and having a deep, clear entrance and fair anchorage; as well as being immediately opposite the coal depôt at Nanaimo.

He thinks Howe Sound has not equal advantages, and that Bute Inlet is more difficult of access than either. This officer states that he has not sufficient knowledge of the inlets, north of Bute Inlet, to express any decided opinion.

(Opinions of Captain Cator.)

Captain Cator has not visited any of the seven inlets referred to during the winter months, but thinks that all inlets north of Bute Inlet would be subject to obstruction from ice. Very bad weather is experienced in the North and Middle Channels in winter, and he thinks that it would be hazardous for a sailing ship to attempt the entrance of northern inlets, even if ice did not exist.

Of the seven inlets specified, Captain Cator would select Waddington Harbour for a main land terminus, and Uchucklesit or Alberni in Barclay Sound as the most suitable for a terminus on Vancouver Island.

(Opinions of Staff Commander Pender.)

Commander Pender states, with regard to the general character of the inlets:—The shores rise abruptly to a considerable height, and the water is, as a rule, too deep or an anchor to be dropped. In some winters there is much floating ice, but he is not aware of any obstructions to navigation on that account. Danger to large ships is more to be apprehended from fogs, gales of wind, with thick weather, strong tides and intricate navigation. In dry summers, smoke from bush fires increases the risks of navigating the inner channels to a dangerous extent.

This officer states that Dean Inlet, Gardner Inlet, and Skeena River entrances are not surveyed, and he cannot speak of them from personal knowledge. He considers Burrard Inlet, with the anchorages at English Bay and other points, of the greatest value: that Howe Sound affords no anchorages at its head: that Waddington Harbour is but an indifferent anchorage, and that Bentinck Arm is even more objectionable as an anchorage for large ships.

He states that the waters north of the Queen Charlotte Islands are unsurveyed, and, so far as his knowledge extends, he would give the preference to Burrard Inlet. Its approach from the ocean is so well defined, charted, and lighted, as to be available for present use by any class of ships. He further states, however, that the risks attending navigation, with large steamships, against time, amongst the islands lying between Juan de Fuca Strait and the Strait of Georgia, are very great.

(Opinions of Lieut. W. Collins.)

Lieut. W. Collins, in reply to the query, "are there any objections of a climatic nature to any of the seven inlets specially alluded to?" states that the climate is all

that can be desired. He admits that his knowledge is very limited, and expresses no opinion respecting the merits or demerits of the several points.

(Proximity of Southern Channel to foreign territory.)

In reply to the query respecting the navigable entrance, from the ocean to harbours inside of the southern half of Vancouver Island, embracing Burrard Inlet, Howe Sound and Waddington Harbour, and its proximity to foreign territory, one of the naval authorities gives $4\frac{1}{2}$ miles, another $2\frac{1}{2}$ miles, and a third, 2 miles, whilst two fix 5 miles as the minimum distance at which vessels would have to pass from the coast of United States.

Admiral Farquhar submits that the distance is not accurately known, but heavy guns on the bluff on the north end of San Juan Island would command the passage.

Admiral Richards states that ships need not pass as far off as within 3 miles of San Juan, but they must pass within 2 miles of Stuart and Patos Islands, unless they take the inner channel, which is dangerous.

All the naval authorities admit that vessels on their course to Burrard Inlet, Howe Sound, or Bute Inlet, would be exposed to the guns of the United States in the event of hostilities, and that the navigation of the channel would greatly depend on the force of the United States in the locality.

(Approach by Seymour Narrows.)

With regard to the possibility of large sea-going vessels passing round the north side of Vancouver, and reaching Burrard Inlet, Howe Sound or Waddington Harbour, *viâ* Johnston's Strait and Seymour Narrows, all the naval authorities, with one exception, express an unfavourable opinion.

Admiral Cochrane replies in the negative, Captain Graham in the affirmative. Captain Cator would not recommend ships attempting it without steam. Admiral Richards, Admiral Farquhar, and Commander Pender, appear to think that "it would not be impossible, but would be attended with an aggravated amount of risks and delays."

(Deductions from Naval Testimony.)

From the naval testimony furnished, taken in conjunction with the admiralty charts, the following deductions may be drawn ;—

1st. That a terminus near the outlet of the River Skeena would prove the nearest to the Asiatic coast, but that no decided opinion can be offered respecting the nautical advantages of a terminus in that quarter, as the waters have not been properly surveyed.

2nd. That as far as known, Burrard Inlet, an arm of the Strait of Georgia, and particularly English Bay at its mouth, is the best harbour and the easiest of approach from the ocean.

3rd. That the Strait of Georgia is separated from the ocean by two archipelagos, one to the north, the other to the south of Vancouver Island.

4th. That the approach by the north of Vancouver Island to the Strait of Georgia is hazardous and objectionable.

5th. That the approach by the south of Vancouver Island is through passages more or less intricate, between, or at no great distance from, islands known as the San Juan group.

6th. That the most important islands of the San Juan group are in the territory of a foreign power, and that from their position, they hold the power of assuming a threatening attitude towards passing commerce.

(Harbours of Vancouver Island.)

Accordingly, it is held important, if practicable, that the railway should terminate at a harbour, to gain which, these islands need, in no way, be approached.

On the outer coast of Vancouver Island there is no lack of harbourage, the whole southern and western shore from Esquimault round to Quatsino, 240 miles being indented with harbours.

An unbroken line of railway, from the railways of the eastern Provinces of the Dominion, to one of these harbours on the outer coast of Vancouver Island, would be exceedingly desirable. All the difficulties of navigation to be encountered in reaching the mainland from the ocean would then be avoided.

(Bridging to Vancouver Island.)

The surveys have, however, clearly shown that the bridging from the main shore to Vancouver would be unprecedented in magnitude, and that its cost would be indeed enormous.

When, in future years, British Columbia is thickly populated, and the coal and iron mines of the islands on the coast form many centres of vast industries, an outlay of capital, now beyond the powers of finance, may be quite practicable. The exigencies of the future may render a continuous line of railway to the outer shore of Vancouver indispensable at whatever cost; but the difficulties which now demand consideration, undoubtedly seem too formidable to be overcome at the present time.

(Ferry by Bute Inlet.)

The connection may now be made by steam ferry, possibly accompanied by some inconvenience and subject to occasional delays. The course of the ferry boats would be along Bute Inlet to the south side of Stuart Island, thence through between the Valdes Islands to Elk Bay on Vancouver Island. The whole of this course is land-locked and smooth water. The distance is 64 miles. The chief difficulty is said to be a strong current for about two hours a day at one point. With this exception, if the railway, for the present, terminated at Waddington Harbour, the water to Elk Bay, could be as easily navigated as an ordinary canal.

(Ferry at Nodales Channel.)

By extending the railway along the western side of Bute Inlet and thence across to Frederick Arm—a feasible scheme, but one exacting a heavy expenditure—"Nodales Channel," a completely sheltered and an easily navigated sheet of water, is reached. This channel is reported to be free from strong currents, shoals, or other difficulties, and could be used by a railway ferry at all seasons of the year. The length of the ferry navigation between Frederick Arm, on the main shore and Otter Cove on Vancouver, is about 15 miles. The length of Railway line from Waddington Harbour to Frederick Arm is about 51 miles. The accompanying chart (Sheet No. 2) shows the relative position of Nodales Channel, Vancouver Island and Bute Inlet.

(Local lines in Vancouver.)

From Elk Bay or Otter Cove, a railway could be carried to Esquimault, or to a much nearer point, Alberni at the head of the Alberni canal, possibly to Nootka or perhaps with still greater ease to Quatsino Sound. Compared with Esquimault, the

SHEET No. 2.


CHART
SHEWING THE RELATIVE POSITIONS OF
BUTE INLET, THE VALDES ISLANDS, NODALES CHANNEL, QUATSINO
AND OTHER POINTS
BRITISH COLUMBIA.
REFERRED TO IN
REPORT ON SURVEYS OF THE CANADIAN PACIFIC RAILWAY, 1877,
Pages 72 to 77.
SANDFORD FLEMING, Engineer-in-Chief.
Projected Railway Line shewn thus
Soundings in Fathoms
QUEEN CHARLOTTE SOUND
SCOTT ISLANDS
GOLETAS CHANNEL
QUATSINO
QUATSINO SOUND
BROUGHTON STRAIT
JOHNSTONE STRAIT
VANCOUVER ISLAND
GILFORD I.
KNIGHT INLET
BUTE INLET
WADDINGTON HARBOUR
LOUGHBOROUGH INLET
DISCOVERY PASSAGE
VALDES ISLANDS
TOBA INLET
DESOLATION SOUND
MALASPINA INLET
CAPE COOK
Long. West from Greenwich
Photo Lith. by the Burland Desbarats Co. Montreal

latter has the advantage of being fully 200 miles nearer the Asiatic Coast. At Quatsino, coal beds are reported to crop out at the water's edge.

The estimated distance between Waddington Harbour and various terminal points on Vancouver Island, are as follows:—

Viâ Nodales Channel.

1.	Waddington Harbour to Frederick Arm—Railway Line.	51	Miles.
	Frederick Arm to Otter Cove—Navigation...........	15	"
	Otter Cove to Esquimault	183	"
	Total...	249	Miles.
2.	Waddington Harbour to Alberni.	159	"
3.	do Quatsino	173	"

Viâ Bute Inlet and Elk Bay.

1.	Waddington Harbour to Elk Bay—all water................	64	miles.
	Elk Bay to Esquimault	180	"
	Total	244	"
2.	Waddington Harbour to Alberni.............................. ..	154	"
3.	do Quatsino.............................	174	"

(Northern Routes.)

The attempts made to reach the Pacific tide water at points to the north of Vancouver Island have been successful, but naval authorities pronounce unfavourably on all the harbours except the most northerly, near the mouth of the River Skeena. With respect to this point, their opinions are expressed guardedly, for the reason that no proper nautical surveys have yet been made there. The same may be said regarding the land surveys, as our explorations to this most northerly point are the least perfect.

(Selection of Route.)

In considering the whole question of route, in connection with that of water terminus, the enquiry may be narrowed down by rejecting all the projected lines and harbours, except the most promising and important.

All the routes across the Mountain Region have been arranged in three distinct groups, *Southern*, *Central* and *Northern.*

There appears to be little doubt that the most eligible of each are the following:—

Route No. 2, of the *Southern* group.

Route No. 6, of the *Central* group.

Route No. 11, of the *Northern* group.

The first mentioned route, No. 2, is the one which follows the course of the Rivers Thompson and Fraser to Burrard Inlet.

Route No. 6 leaves No. 2 at Tete Jaune Cache, and passing to the north of the Cariboo Mountains, by the upper River Frazer, to Fort George, finally reaches Bute Inlet, by the River Hamathco.

No. 11 is the route projected to leave No. 6 not far from Fort George, thence continuing in a westerly direction, and following the River Skeena to Port Essington, or the best harbour in that quarter.

(Route *viâ* Bute Inlet.)

If it be considered of paramount importance to carry an unbroken line of railway to one or more of the harbours on the western coast of Vancouver Island, and there is a likelihood that this project will, regardless of cost, hereafter be seriously entertained, then Route No. 6 becomes of the first importance, and really the only one open for selection.

(Route to Burrard Inlet.)

If, on the other hand, the object be to reach the navigable waters of the Pacific simply by the most eligible line leading to a good terminal harbour, it is clear that of the three routes specified, No. 6 must yield to No. 2, as Waddington Harbour is open to all the objections which may be urged against Burrard Inlet with regard to the passage from the open ocean. Waddington Harbour has serious disadvantages not possessed by Burrard Inlet, and has no advantages to compensate for these deficiencies. In this view there remain only Routes Nos. 2 and 11 to be compared.

Route No. 2, although expensive to construct, would undoubtedly, when completed, possess engineering features comparatively favourable for the purpose of cheap transportation. It would terminate at a harbour which is held to be good and sufficient, and it would possess the advantages which have been elsewhere set forth.

SHEET No. 3.

CHART
SHEWING THE RELATIVE POSITIONS OF
BURRARD INLET, NANAIMO, ALBERNI, ESQUIMALT
AND OTHER POINTS
BRITISH COLUMBIA
REFERRED TO IN
REPORT ON SURVEYS OF THE CANADIAN PACIFIC RAILWAY, 1877,
Pages 74 to 77.
SANDFORD FLEMING, Engineer-in-Chief.
Projected Railway Line shewn thus
Soundings in Fathoms.
VANCOUVER ISLAND
STRAIT OF GEORGIA
BURRARD INLET
ENGLISH BAY
PORT MOODY
NANAIMO
ALBERNI
ALBERNI CANAL
BARCLAY SOUND
CLAYOQUOT SOUND
JUAN DE FUCA STRAIT
ESQUIMALT
VICTORIA
SAN JUAN I.
ORCAS ISLAND
LOPEZ I.
FIDALGO I.
WHIDBEY I.
ADMIRALTY INLET
HARO STRAIT
ROSARIO STR.
BELLINGHAM BAY
GALIANO I.
VALDES I.
GABRIOLA I.
TRINCOMALIE CHAN.
STUART CHANNEL
ADMIRAL I.
Fraser River
Sumass Lake
TEATE INDIANS
Harrison River
SURVEYED LINE FOR RAILWAY
International Boundary Line
WASHINGTON TERRITORY
Mt. Baker 10694
Mt. Arrowsmith
New Westminster
Lon: 125° West from Greenwich

(Proximity to the Frontier.)

An objection urged against a terminus at Burrard Inlet is that access might be difficult from the ocean in the event of hostilities with the United States. The objection, together with the fact that the railway itself from Burrard Inlet to Hope, would run for some 60 miles close to the frontier, claims attention and points to the risk of the communication being impeded on occasions when the railway might be most imperatively demanded. The opinion of a distinguished military officer on this question will be found in the appendix.*

(Ferry to Nanaimo.)

The danger of communication between the ocean and the terminus being interrupted or broken might, to some extent, be obviated by establishing a railway across Vancouver Island and by keeping open the water communication across the Straits of Georgia.

Nanaimo is situated almost directly across the Strait of Georgia from Burrard Inlet, and the length of navigation between them is about 50 miles. From Nanaimo, a railway may be carried either to Esquimalt, 68 miles, or to Alberni, on the Alberni Canal, 52 miles, both harbours being outside the San Juan Islands.

By this arrangement, Route No. 2 would assume a position similar to Route No. 6, with a ferry from the mainland to Elk Bay and railway connection to the outer coast of Vancouver : the only important difference being the character of the navigation. In the case of route No. 6, the water would invariably be smooth, while in the case of No. 2, the open waters of the Strait of Georgia, about 23 miles in breadth by a length much greater, would have to be crossed. The chart which accompanies this (Sheet No. 3) shows the relative position of Burrard Inlet, Nanaimo, Alberni, Esquimalt and the San Juan Islands.

(Extreme Northern Route.)

The route (No. 11) by the River Skeena is not open to the same objections as the routes which reach the Pacific within the limits of the Strait of Georgia. Neither the line nor its terminus is contiguous to foreign territory. It lies almost 500

---

* *Vide* Appendix W, page 312, Memorandum on the military aspect of the Burrard Inlet route, by Major-General Selby Smyth.

miles nearer the quarter whence through traffic may be looked for. The terminus would be abreast of Queen Charlotte Islands, the climate, soil and resources of which are, probably, not inferior to those of Vancouver Island (opposite the termini of lines Nos. 2 and 6.) They offer a promising field for industry, and open a prospect for that traffic which a railway, to be self-supporting, must control. But this more northern point is not known favourably to the naval authorities. Those who express themselves with regard to it do not offer serious objections to its selection; they rather suggest that a complete nautical survey is demanded before any decided opinion can be given. Such an examination, together with the necessary surveys on land, may develope difficulties of a nature to render the project of this route untenable; or on the other hand, they may establish beyond doubt that the northern route is the one which, in Imperial as well as Dominion interests, ought to be adopted.

(Terminus at Frederick Arm.)

One other point demands consideration :—How far would Route No. 6, extended to Frederick Arm, meet the objections to a terminus within the Strait of Georgia? An examination of the chart shows Frederick Arm to be approachable from the north side of Vancouver Island, by Queen Charlotte Sound and Johnstone Strait. It is thus somewhat favourably situated for the Asiatic trade, ocean-going steamers being able to reach it by open channels in less time than any port within the Strait of Georgia.

It will be necessary to ascertain how far Frederick Arm is suitable for a terminal harbour; my present duty is to suggest its possibilities, and, if it be found eligible, to point out the advantages which may be looked for.

It is apparent that Route No. 6, extended to Frederick Arm, would touch the navigable waters of the Pacific at two points. Waddington Harbour, on the one hand, would accommodate the traffic centering around the Strait of Georgia, or finding entry by the Strait of Juan de Fuca; whilst, on the other, Frederick Arm would command the Asiatic trade, and accommodate the traffic of the northern half of Vancouver and of the Queen Charlotte Islands, when, in course of time, they become settled, and their resources developed.

(Through Distance *via* Mainland Harbours.)

The mileage by land and water between common points on the Asiatic coast and the Rocky Mountains *viâ* harbours on the mainland, is estimated to be as follows:—

Yokohama to Yellow Head Pass.	Ocean Navigation.	Towage for Sailing Ships.	Railway Line.	Total Mileage.
	Naut. Miles.	Naut. Miles.	Stat. Miles.	Naut. Miles.
Viâ Port Essington and Route No. 11	3,870	50	*	*
" Frederick Arm and Route No 6	4,110	120	590	4,628
" Waddington Harbour and Route No. 6	4,470	155	546	4,944
" Port Moody and Route No. 2	4,355	90	493	4,783

(Through Distance *via* Vancouver Harbours.)

The mileage by land and water between the same common points, *viâ* harbours on the Pacific shore of Vancouver Island and the several routes designated, embracing ocean navigation, railway on the island, ferryage, and railway on the mainland is estimated to be as follows:—

Yokohama to Yellow Head Pass.	Navigation.		Railway Lines.	Total.
	Ocean Ships.	Ferryage.		
	Naut. Miles.	Stat. Miles.	Stat. Miles.	Naut. Miles.
Viâ Quatsino, Otter Cove to Frederick Arm ferry and Route No. 6	4,040	15	704	4,664
" Quatsino, Elk Bay to Waddington ferry and Route No. 6	4,040	65	656	4,666
" Alberni, Otter Cove to Frederick Arm ferry and Route No. 6.	4,210	15	690	4,822
" Alberni, Elk Bay to Waddington Harbour ferry and Route No. 6	4,210	65	636	4,819
" Alberni, Nanaimo to Port Moody ferry and Route No. 2	4,210	50	545	4,727
" Esquimault, Otter Cove to Frederick Arm ferry and Route No 6	4,265	15	780	4,955
" Esquimault, Elk Bay to Waddington Harbour ferry and Route No. 6	4,265	65	726	4,952
" Esquimault, Nanaimo to Port Moody ferry and Route No. 2	4,265	50	561	4,796

*These distances have not been ascertained.

In addition to the evidence of Her Majesty's naval officers, on the harbours and waters of the Pacific Coast, the views of sea captains, pilots and others, resident in British Columbia or locally interested, will be found in the Appendix.*

The Prairie Region.

Passing from the Mountain to the Prairie Region, the difficulties of route have been fortunately surmounted. From the eastern boundary of British Columbia to Red River, a distance of 1,043 miles, the line is practically established. On 787 miles the telegraph has been erected.

(The Telegraph Preceding the Railway.)

It was suggested, at an early period, that telegraphic communication should be secured along the entire line of railway. Apart from the advantages resulting from direct communication between British Columbia and other Provinces of the Dominion, it was held that the telegraph running continuously along the line of railway, would not only facilitate its construction, but favourably effect its cost, and at the same time largely assist in the settlement of the country. † Accordingly, contracts were entered into for the erection of the telegraph as soon as the location of the line was established.

(Establishment of Stations.)

In addition to recommending that the telegraph should be the forerunner of the railway, the writer felt it his duty to point out;—that it was desirable to determine the sites for stations at intervals along the line; that the station sites could best be selected in advance of settlement, before municipal or private interests were created to interfere with the choice, and when engineering principles alone need be consulted. It was also represented that road crossings, especially level road crossings, so often the source of serious accident, should be reduced to a minimum; that, indeed, there should be no level crossings, except at stations where trains run with caution, and that farm crossings should be entirely abolished.

A correspondence took place setting forth the advantages to be derived from this policy, and recommending that, in laying out the land for occupation, a comprehen-

* *Vide* Appendix V, page 303, Letters and statements, etc., by local authorities, on some of the harbours of British Columbia.

† *Vide* Sessional Papers (No. 83), Vol. 6, Province of Canada, 1863.

sive system embracing these precautions should be carried out, in advance of settlement, as the present opportunity would never again occur.*

(Reserves for Railway Purposes, Town Plots, etc.)

These views were concurred in, and directions were given to act in accordance with them. Consequently, a reservation of land, one mile in width on each side of the railway, throughout the entire length, has been made, and sites for stations have been selected throughout the whole extent of the Prairie Region. These sites have been designated by names. Town plots will, as circumstances require, be laid out in their neighbourhood. The telegraph is already far advanced ; and the railway will in due time follow. Each point will thus become a nucleus for population, as the work of construction progresses and as settlements advance. There will then be established at suitable intervals, and under circumstances the most favourable, a succession of villages, some of which, in time, will become cities, whose population will sustain the railway by the travel and traffic it will create.

The stations are designated on the map. A list with the altitude and the distance of each from Lake Superior is given in the Appendix.†

Character of the Country.

The character of the country and its capability for sustaining a large population have now to be considered. Information on this head has gradually been accumulated, and although certain drawbacks claim recognition, there can no longer be any doubt respecting the salubrity of the climate and the extent of the natural resources of the territory. A report in the Appendix gives the result of enquiries up to the present time.‡

It has been discovered that the great American Desert, known to extend northwards across the frontier of the United States, is more limited on the Canadian side than was previously supposed, and that a great breadth of the country which has been considered valueless, may be used for pastoral purposes, and some of it ultimately brought under cultivation. A large area of fertile land is to be found south

* *Vide* Appendix B, page 90, Correspondence respecting the location of Stations.

† Appendix B, page 96.

‡ *Vide* Appendix X, page 312, Sketch of the agricultural capabilities of that portion of Canada between Lake Superior and the Rocky Mountains, by Professor Macoun.

of the line of railway, on the eastern flank of the Rocky Mountains, extending to the frontier on the 49th parallel, while to the north, in the same relative position, vast plains, of rare fertility and salubrious climate, present themselves for occupation by the husbandman.

The gentleman who has prepared the report on this subject, furnished in the Appendix, having personally examined the region and devoted much attention to the enquiry, is considered an excellent authority. He estimates that there are between Lake Superior and the Rocky Mountains no less than 160,000,000 acres of land available for farming or grazing purposes, of which one-half, or 80,000,000 acres, may be considered cultivable.

In order to convey some definite comparative idea of the extent of this area, it may be mentioned that the total acreage under crop in the fine agricultural Province of Ontario is considerably less than 7,000,000 acres, and the whole area under cultivation and permanent pasture in Great Britain and Ireland is 47,019,106 acres.* Of this there are in crop, pasture under rotation, orchards, woods and plantations, 26,031,410 acres.

If the estimates are well founded, it would thus appear by comparison that the central plains of Canada give promise of an important future.

* The following table is compiled from Agricultural Returns, for the year 1874, submitted to the Imperial Parliament:—

	1	2	3	4
——	Total area of land of all descriptions, and of water, in statute acres.	Total area under all kinds of crop; bare fallow, grass under rotation, and permanent pasture	Permanent pasture, included in Column 2.	Balance in crop, or pasture under rotation.
England	32,597,398	24,008,368	10,438,149	13,570,219
Wales................	4,721,823	2,678,730	1,633,542	1,045,188
Scotland	19,496,132	4,579,821	1,106,321	3,473,500
Ireland	20,819,829	15,752,187	10,472,161	5,280,026
Total	77,635,182	47,019,106	23,650,173	23,368,933

Orchards, woods, coppices and plantations not included in the above, except in Column 1:—

England..................	Orchards,	145,622	Woods and plantations,	1,325,765	Total,	1,471,38
Wales	do	2,994	do	126,823	do	129,817
Scotland	do	1,910	do	734,490	do	736,400
Ireland....................	do	Nil.	do	325,173	do	325,173
Total acres......	do	150,526	do	2,512,251	do	2,662,777

(Central Position of the Trunk Line.)

The line of railway will be too remote fully to serve every fertile district. A single line crossing a breadth of territory so great must necessarily be at a considerable distance from many portions. But the location adopted will be found to follow a generally central course. It will pass through or be adjacent to many valuable sections, and will form the trunk line, from which branches can be extended to other districts more remote, as soon as settlement and traffic may justify their construction. It has been considered important, in the first place, to secure for the main trunk line the shortest route obtainable.

The Woodland Region.

It has been held from the first, that the successful occupation of the Prairie Region, and the extent to which it may become thickly populated, will, in a great measure, be governed by the capability of the line to Lake Superior to carry cheaply the products of the soil. The success of the railway itself must be determined by the number of inhabitants which can be established in the country; and the degree of prosperity of the population will be influenced in no narrow limit by the character of the outlet for the products of their industry. The more, therefore, that the eastern section of the Railway can be rendered available for cheap transportation, the more rapidly will the Prairie Region become populated, and the more speedily will the line become self-sustaining.

I have felt it my duty to regard these views as of paramount importance in the location of the line between the Prairie Region and Lake Superior. Accordingly, every effort has been made to discover the shortest line with the lightest possible gradients and easiest curvature, especially in the direction which heavy traffic will take—towards the Atlantic seaboard.

(Favourable Gradients.)

On the sections placed under contract, from Red River to Keewatin, 114 miles and from English River to Fort William, 113 miles, the maximum gradients are as follows:—

Ascending East.

					per 100	per mile
On Tangents and 1½° Curves, equal	to	3,820	feet Radius	...	0·50	26·40 feet
On 2°	"	"	2,865	" ...	0·45	23·76 "
On 3°	"	"	1,910	" ...	0·40	21·12 "
On 4°	"	"	1,433	" ..	0·35	18.48 "

Ascending West.

					per 100	per mile
On Tangents and 1½° Curves, equal	to	3,820	feet Radius	...	1·00	52·80 feet
On 2°	"	"	2,865	" ...	0·90	47·52 "
On 3°	"	"	1,910	" ..	0·80	42·24 "
On 4°	"	"	1,433	" ..	0·70	36·96 "

On the remaining distance to be placed under contract, between Keewatin and English River, 183 miles, equally easy gradients have not been, as yet, at every point, secured. At the few exceptional points, the location will, however, be revised, and I have confident expectations that all the gradients will be reduced to the same standard, without materially increasing the cost of the works.

Thus, there will be no impediment to the Pacific Railway carrying products from the heart of the continent to Lake Superior at a lower rate per mile than those now obtaining on the leading railways already in operation.

(Prospective Local Traffic.)

The Woodland Region does not offer any great prospect of becoming an agricultural country, but it may, possibly, contain much mineral wealth. The investigations of the Geological Survey suggest the presence of rich deposits, extended over a wide area. Prominently may be mentioned iron, copper, silver and lead, and, not improbably, phosphates and plumbago. Even the section of country east of Lake Superior may prove rich in minerals. This section has not, hitherto, been held in high estimation, but it has been discovered that a broad belt of metalliferous rocks stretches from the vicinity of the Bruce Mines to Lake Mistassinni, and between it and the shores of Hudson Bay. Copper lodes have for some time been worked at the Bruce Mines, and silver lodes have been discovered at Garden River. It is a reasonable inference that similar lodes will be found repeated in the extensive tract of

country of the same geological horizon, and that the day will come when these resources will be developed, and a considerable mining population find employment.

(The Line Ultimately Continuous.)

The line projected for the Railway through this section, makes the distance from Selkirk to Ottawa, 670 miles less than by the winter route through the United States.* It is, therefore, not improbable that by the time the portion of the Railway between Lake Superior and the Pacific Coast has been completed, and the Prairie Region has become well populated, a direct link between Lake Superior and the older Provinces will be demanded.

It seems a prudent course to take some steps to make this section, now a roadless wilderness, more accessible than it is at present. I would not recommend any great immediate expenditure. But whatever may be the future policy of the Dominion with regard to the construction of this link, I would advise that the Railway line be located from Lake Superior to Lake Nipissing on the shortest and best course, and that it be gradually cleared of its timber, so as to admit of a "Territorial Road"† being formed, and the interior thus made more accessible to mineral prospectors and others. If the line were cleared of its timber, the construction of a telegraph would doubtless follow in due time. Existing contracts will very soon secure the completion of the overland telegraph from the Pacific coast to Fort William. A connection between the latter point and the telegraph system to the East will be called for, and it is not improbable that, the line being cleared, competing private Companies would make an effort to establish the connection on terms acceptable to the Government.

Snow Fall.

In a previous report,‡ allusion was made to the character of the climate throughout the entire line of route. No information has since been obtained of a nature materially to modify the views which were there expressed.

---

* Selkirk to Montreal by	Chicago	and Detroit,	1,890 miles.	By	Canadian	Pacific Line,	1,280 miles.
Selkirk to Ottawa by	do	do	1,830 miles.	By	do	do	1,160 miles.
do Toronto by	do	do	1,557 miles.	By	do	do	1,165 miles.

† *Vide* Sessional Papers (No. 83), Vol 6, Province of Canada, 1863.

‡ *Vide* Report January, 1874, p. 341.

The climate of the several regions to be traversed by the railway is, greatly influenced by the characteristics of the surface. The vast lakes, elevated plateaux, extensive lowland treeless plains, lofty ranges of mountains and immense forests have each their effect on the temperature and humidity of the atmosphere; and the degree of cold in winter, as well as the snow-fall, is largely affected by the nature of individual localities.

The chief point of consideration is the snow-fall, and the experience of the various surveying parties, extending, as it now does, over a period of six winters, has afforded many interesting and important data. Taking the snow-fall at Ottawa as the standard, the depth of snow throughout the whole of the woodland region is generally less, on an average, than at that city. In the immediate neighbourhood of Lakes Huron and Superior the fall is about the same; but east of Lake Nepigon it is found to be from 90 to 70 per cent., while from Lake Nepigon to Manitoba the depth ranges from 70 to 50 per cent. of the Ottawa snow-fall. Throughout the Prairie Region, the snow rarely exceeds 20 to 24 inches in depth, and is frequently much less over wide areas. In the Mountain Region the features of climate and extent of snow-fall are far more varied. The western slopes of the Cascade and Rocky Mountain chains are more abundantly supplied with rain in summer and with snow in winter; the eastern slopes being subject to comparatively little precipitation. Only on the western sides of the Mountain chains, where the snow-fall is excessive, will portions of the line require to be shedded. Generally speaking, with these exceptions, the snow fall appears to average less than in the older provinces.

(Deductions from Meteorological Observations.)

From meteorological observations made during three years in the Rocky Mountains, Professor Kingston, of the Toronto Observatory, has carefully compiled tables which show that, though in some of the passes and portions of river valleys the snow may average from four to five feet in depth, in general the fall is far below that of Ottawa, Quebec and Montreal; while to the east of the Rocky Mountains, between Jasper Valley and Edmonton, it does not much exceed half that of Ottawa. During the winter of 1875-6, in which the snow-fall was exceptionally heavy, a survey party located at Tête Jaune Cache made a series of

observations,* from which it appears that though the aggregate amount of snow was no less than 112 inches, at no time was there more than four feet on the ground at the summit, extending to five feet at the foot of Moose Lake. Owing to the unusual snow-fall, the Athabasca Valley—which had been previously considered by the employés of the Hudson's Bay Company and the Indians as a locality which might be safely relied on for wintering stock, and which was so spoken of in my former report of '74—proved very disastrous to the party; their horses and cattle suffered severely, and less than half survived the winter. With respect to the cold, Professor Kingston shows that though the cold of the autumn is more severe in the Rocky Mountain district than in Ontario, Quebec and the Maritime Provinces, yet the winter itself compares favourably with that of Eastern Canada.†

Located Line Favourable for Cheap Transportation.

I have described the efforts that have been made to obtain a line with the easiest possible gradients from the Prairie Region to the navigable waters of the St. Lawrence, and the paramount importance of this feature. Reference to a table in the Appendix, which gives a summary of gradients for each hundred mile section of the railway between the Lake Superior terminus and Tête Jaune Cache shews that there is no gradient ascending in either direction exceeding 1 per 100 or 52·8 ft. per mile, and with one single exception, viz. at the crossing of the South Saskatchewan, the heaviest gradient ascending eastwards from a point near Battleford to Fort William is only 0·5 per hundred or 26·4 ft. per mile.‡ I feel satisfied that a revision of the location at the one exceptional point will, with but trifling cost, result in obtaining the desired gradient there also.

Assuming the gradient at the South Saskatchewan to be amended, I am enabled to report a location on which, for fully a thousand miles west of Lake Superior, the easterly ascending gradients can be kept down to half the maximum gradients on the Grand Trunk and other railways in operation in the older Provinces. Cheapness of transportation is thus, to a certain extent, assured,

---

* *Vide* Appendix Z, page 353, Memoranda respecting the winter climate of the Rocky Mountains, by George A. Keefer, C.E.

† *Vide* Report, January, 1874.

‡ *Vide* Appendix A, page 89, Table of gradients between Lake Superior and Tête Jaune Cache.

an important element in facilitating the prosperous settlement of the fertile territory in the interior.

(Summary of Gradients.)

The following will show the remarkably favourable gradients secured on each 500 mile section of the line, west of Lake Superior; and the accompanying diagrams (Sheets Nos. 6 and 7) will clearly illustrate this feature of the line:

Sections of 500 miles each, west of Lake Superior.	Ascending East.				Level.	Ascending West.			
	Under 16 ft. per mile.	Above 16 ft. and under 26½ ft. per mile.	Above 26½ ft. and under 53 ft. per mile.	Total.		Under 16 ft. per mile.	Above 16 ft. and under 26½ ft. per mile.	Above 26½ ft. and under 53 ft. per mile.	Total.
First 500	74·97	130·31	....	205·28	143·00	61·24	27·71	62·77	151·72
Second 500	68·24	79·84	....	148 08	170 50	94·77	43 01	43·64	181·42
Third 500	38·78	46·55	93·76	179·09	131·55	38 17	43·12	108 07	189·36
Total miles, 1500	181·99	256·70	93·76	532·45	445·05	194·18	113·84	214·48	522 50

Thus on that portion of the line located and established for a distance of 1,500 miles there will be close on 1,200 miles level, or with gradients under 26½ feet per mile, and no portion of the balance will rise more than 53 feet per mile.

It has already been stated that the line throughout its whole extent will compare favourably in all important particulars with the trans-continental railway extending from San Francisco to New York. The difference between the gradients of the two is indeed remarkable, when it is considered that the crest of the Rocky Mountain chain attains the highest elevation to the north of the International Boundary. The Canadian Pacific Railway, however, will run through the mountain masses by low lying passages which do not exist on the more southern route. I have prepared a general profile of the line from Lake Superior to the Pacific Coast, and on this have shown in a brown colour the profile of the line from San Francisco to Omaha (Sheet No. 6). An inspection will show at a glance the marked difference between the two lines.

The Engineering Staff.

In a report of this character, I should be guilty of injustice to my Staff were I to omit allusion to the untiring efforts, hardships and privations of the engineering parties who have acted under my directions in carrying out the explorations and surveys.

To one unaccustomed to the consideration of matters of this nature, it is difficult even to convey an accurate impression of the magnitude of the work executed; a work which has every year employed the best energies of not far short of one thousand men of all grades.

(The Work Done.)

The length of the various lines surveyed and routes explored amounts in the aggregate to close on 46,000 miles, of which no less than 11,500 miles have been laboriously measured, yard by yard, through mountain, prairie and forest, with the spirit-level, chain and transit. Large as the mileage of examinations undoubtedly is, it yet forms only a very imperfect factor in estimating the energy expended in the work, and but faintly suggests the toilsome, unflagging labour which has been necessary to encounter difficulty after difficulty; labour too often resulting only in failure.

I pay but a just debt when I acknowledge my deep obligations to my fellow-labourers, who have so zealously toiled to obtain the information of which this Report is a synopsis.

My own feeling would lead me to make special mention of the more meritorious members of my Staff, but where so many have rendered the heartiest service, it is difficult to give prominence to individual names.

(Character of the Service.)

Much of the work has been carried on amidst the severities of winter, frequently, in an exceedingly low temperature. The surveying parties were far removed from all habitations, and were supplied with but inadequate shelter and diet, although both were the best that circumstances would admit of. Notwithstanding every precaution, scurvy has occasionally attacked both officers and men; and, as the work has been often hazardous, some have met with serious accidents in the discharge of their duty. Many have returned with constitutions more or less impaired by the

vicissitudes of the life to which they have been exposed. I feel that their services,* which have already been recognized by the Government, merit also the appreciation of the public.

(Losses Sustained.)

It is my sad duty to mention that thirty-four have lost their lives in connection with the survey.*

Conclusion.

I have endeavoured, in the previous pages, to narrate the efforts made during the last six years to obtain the most eligible Railway line to the Pacific Coast.

I have set forth the operations by which we have established an extremely satisfactory line from the head of the St. Lawrence navigation on Lake Superior to Tête Jaune Cache, on the western side of the great continental "divide" in the main Rocky Mountain chain.

I have described, in its various stages, the work which has been executed to attain this result, as well as the operations by which we have pierced ranges of mountains, in the western section of the country, previously reported as impenetrable.

It was early discovered that a line could be obtained by the Yellow Head and Albreda Passes, following the natural descent of the Rivers Thompson and Fraser to tide water. But the forbidding character of the valleys, and the extreme ruggedness of the chasms through which these rivers in parts of their course flow, call for works so formidable and costly, that attempts have been made to discover a more eligible route.

I have not concealed that our efforts have frequently resulted in failure, rendering repeated attempts necessary, year by year, to gain the objects sought; and, although the route of the Railway in the Western region has not been definitely established, I have pointed out that several practicable lines have been found, and that we have discovered passes and traced lines which, considering the altitude of the mountain masses of the Region, are more favourable than could have been hoped for.

Although several routes from the mountains to the coast are available, it cannot be claimed that any line has been found upon which, in some parts of its course, no serious difficulties are met. Besides difficulties of construction, involving a large expenditure, the question is complicated by other important considerations which lie beyond the province of the Engineer.

* *Vide* Appendix Z *b*, page 382.

So far as an Engineer can venture to deal with the various points which call for examination, I have striven faithfully to ascertain the necessary facts, and to present them in a clear manner for the consideration of the Government.

To assist in drawing conclusions respecting the selection of the terminus, I have submitted the opinions of distinguished naval officers respecting the harbours and channels of the coast. I have, likewise, presented the views of other experienced men on matters bearing on the subject.

The inferences to be drawn appear to point conclusively to a choice of two distinct courses:—the selection of one of the two routes which first reach the Pacific waters at Burrard Inlet and at Bute Inlet; or the postponement of a decision respecting the terminus until further examination be made on land and water to determine if a more eligible route can be obtained by the River Skeena.

On account of the extent and nature of the subject discussed in this Report, I have deemed it advisable to avoid, as much as possible, matters of detail. Generally, however, references are given to sources whence full information may be obtained.

The documents appended give much information hitherto unpublished. They are replete with detailed descriptions of the Survey. The excellent reports on the agricultural capabilities of the country will be read with especial interest, as they establish that a vast territory is available for agricultural and pastoral purposes.

The report from the Geological Survey on the economic minerals and mines of British Columbia is a valuable contribution to our knowledge of the Western portion of Canada; more especially in view of the field offered for mining industry.

It has been my object in this report, and in the Appendices herewith submitted, to place on record a concise history of the preliminary operations connected with the construction of the Pacific Railway, from the commencement in 1871 to the present date, and to furnish other important information. During these six years, with the assistance of an able and zealous staff, I have given my most earnest efforts to obtain satisfactory results; I trust I have succeeded in my endeavour to describe, in a faithful and comprehensive manner, all that we have effected.

I have the honour to be, Sir,

Your obedient servant,

SANDFORD FLEMING,

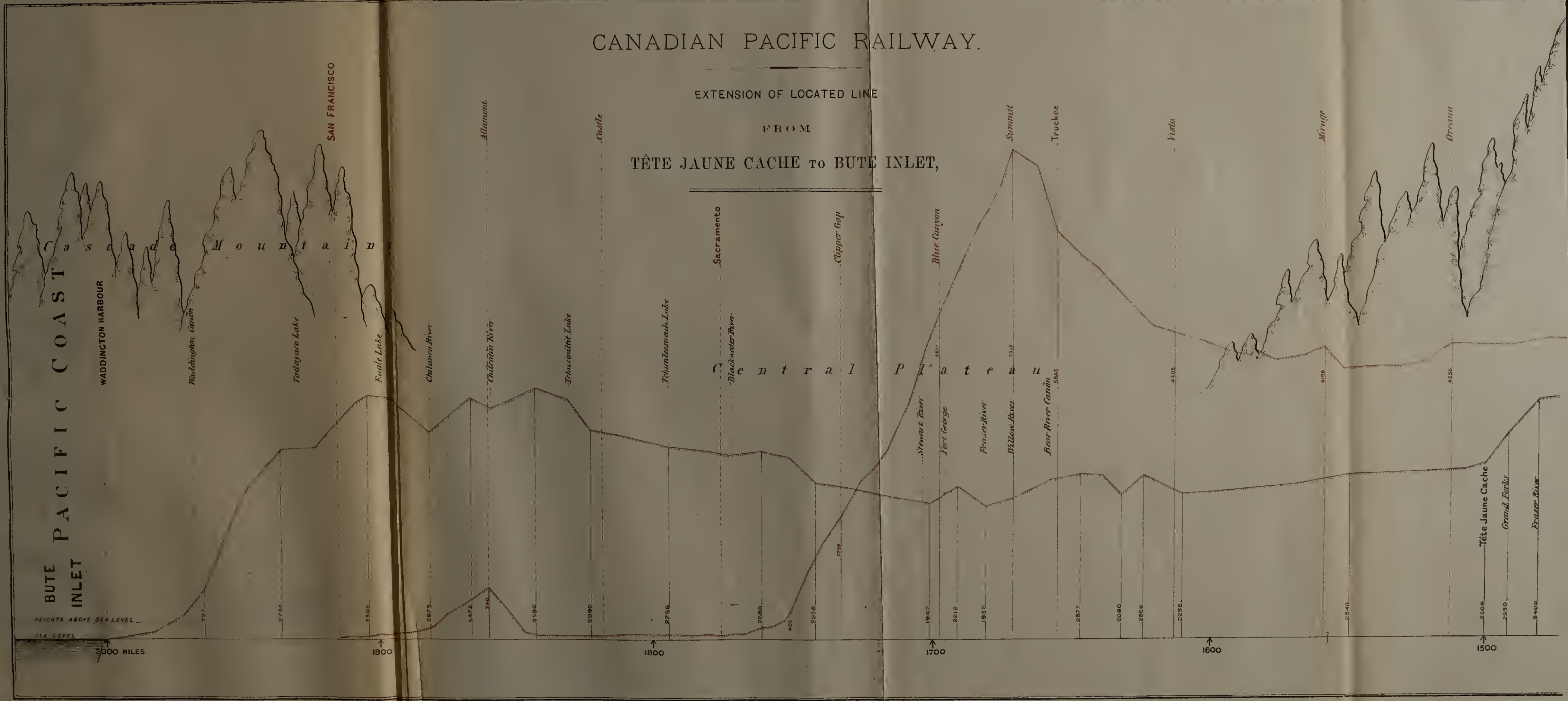
Engineer in Chief.

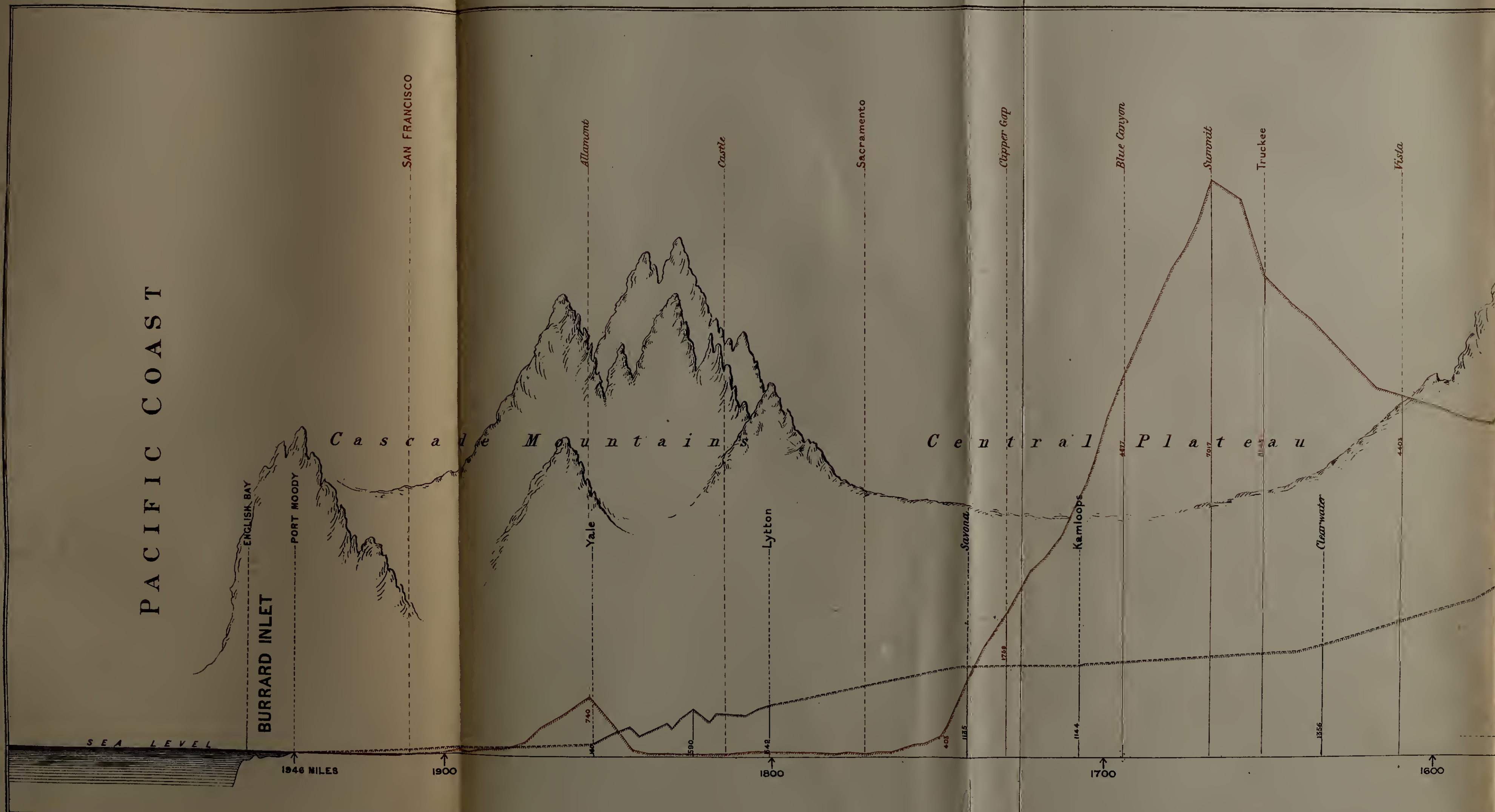
CANADIAN PACIFIC RAILWAY.

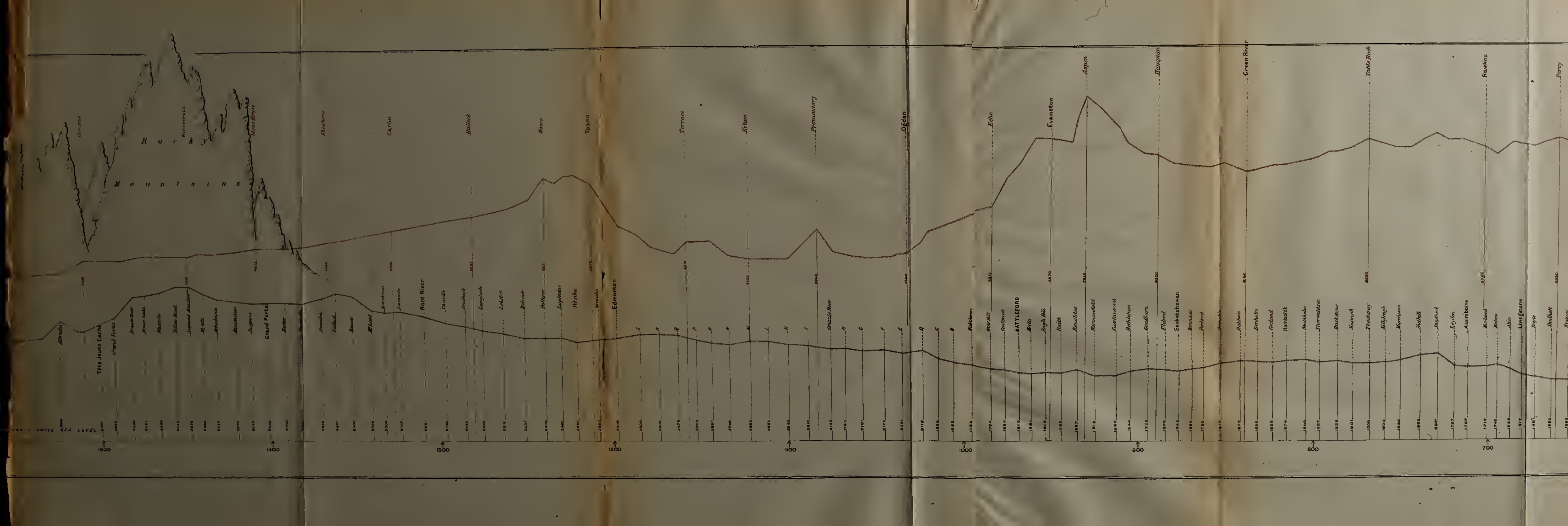
EXTENSION OF LOCATED LINE

FROM

TÊTE JAUNE CACHE to BUTE INLET,




PACIFIC COAST
BURRARD INLET
ENGLISH BAY
PORT MOODY
SAN FRANCISCO
Altamont
Castle
Sacramento
Clipper Gap
Blue Canyon
Summit
Truckee
Vista
Cascade Mountains
Central Plateau
Yale
Lytton
Savona
Kamloops
Clearwater
SEA LEVEL
1946 MILES
1900
1800
1700
1600



SHEET No. 6.

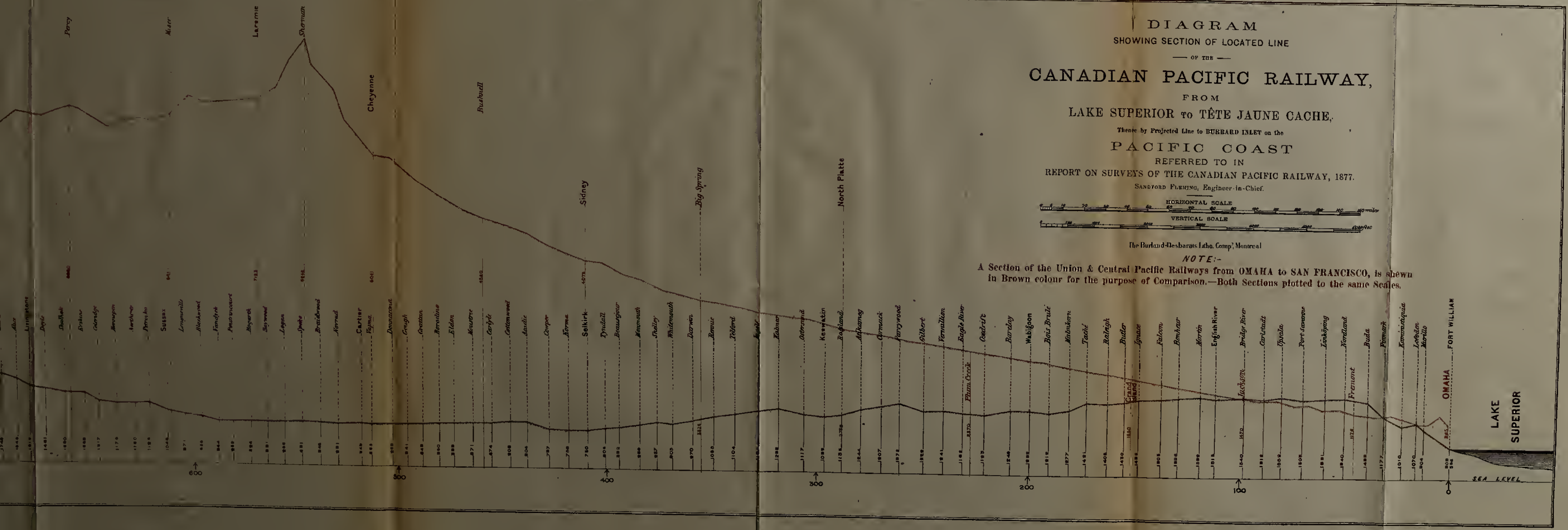


DIAGRAM
SHOWING SECTION OF LOCATED LINE
— OF THE —
CANADIAN PACIFIC RAILWAY,
FROM
LAKE SUPERIOR TO TÊTE JAUNE CACHE,
Thence by Projected Line to BURRARD INLET on the
PACIFIC COAST
REFERRED TO IN
REPORT ON SURVEYS OF THE CANADIAN PACIFIC RAILWAY, 1877.
SANDFORD FLEMING, Engineer-in-Chief.
HORIZONTAL SCALE
VERTICAL SCALE
The Burland-Desbarats Litho. Comp.y Montreal
NOTE:-
A Section of the Union & Central Pacific Railways from OMAHA to SAN FRANCISCO, is shewn in Brown colour for the purpose of Comparison.—Both Sections plotted to the same Scales.
Sherman
Laramie
Cheyenne
Sidney
Big Spring
North Platte
Grand Island
Jackson
Fremont
OMAHA
FORT WILLIAM
LAKE SUPERIOR
SEA LEVEL
600
500
400
300
200
100
0

APPENDICES.

APPENDIX A.

TABLE OF GRADIENTS BETWEEN LAKE SUPERIOR AND TÊTE JAUNE CACHE, IN THE ROCKY MOUNTAINS.

Sections West of Lake Superior.	Level.	Rise per 100.—Ascending Easterly.								Rise per 100.—Ascending Westerly.							
		0·10 to 0 20	0 20 to 0·30	0·30 to 0·40	0·40 to 0·50	0·50 to 0·60	0·60 to 0·70	0·70 to 0·80	0·80 to 1·00	0·10 to 0·20	0·20 to 0·30	0·30 to 0·40	0·40 to 0·50	0·50 to 0·60	0 60 to 0·70	0·70 to 0·80	0·80 to 1·00
1st. 100 mile section	21·29	6·38	3 62	5 15	14·39	....	....	....	....	9·26	5·63	4·56	4·11	1·88	4·26	4 47	15·00
2nd. do	25·67	9·76	5·05	6·61	26·36	....	....	....	....	7·96	3·04	3·43	3·60	0·88	0·89	1·42	5·33
3rd. do	20·93	4·83	1·03	20·47	26·14	....	....	....	....	2·61	1·79	1·32	2·85	1·47	1·60	3·56	11·40
4th. do	20 78	19·70	6·19	13·81	13·28	....	....	....	....	12·14	1·19	1·59	2·42	2·46	2·29	0·76	3·39
5th. do	54·33	12·17	6·24	3·18	0·92	....	....	....	....	14·66	2·96	2·70	1·13	0·42	0·39	....	0·90
6th. do	52·35	9·70	5·18	2·26	4·73	....	....	....	....	10·76	3·89	4·32	2·97	1·83	1·53	0·48	....
7th. do	27·52	6·52	2 68	2·25	9·25	....	....	....	....	14·25	10·85	8·27	4·48	3·16	1·16	5·29	4·32
8th. do	35·97	6·25	7·33	4·88	8·98	....	....	....	....	18·56	3·68	1·83	7·07	....	2·27	....	3·18
9th. do	30·01	6 65	3 61	1·92	23·04	....	....	*1·75	....	11·05	5·90	3·90	4·84	4·93	....	0·57	1·83
10th. do	24·65	15·94	4·38	8·10	12·68	....	....	....	....	8·71	7·12	3·48	1·85	4·21	1·63	4·55	2·70
11th. do	28·43	5·44	2·47	1·53	5·42	9·49	....	1·33	4·42	9·36	2·47	6·65	2·81	1·32	3 06	4·46	11·34
12th. do	27·99	6·53	4·66	5·77	7·61	8·08	1·49	....	3·00	4·14	6·54	2·27	6·21	3·51	4·07	2·32	5·81
13th. do	23·43	6·12	5·20	1·59	7·57	4·43	2·07	2·85	6·76	2·30	1·48	3·89	3·12	6·00	3·06	2·97	17·16
14th. do	25·23	....	3·63	0 59	9 28	1·20	3·42	2·67	12·77	2·47	0·97	1·96	5·44	5·46	2·08	2·62	20·21
15th. do	26·47	2·26	2 47	4·48	2·71	2·64	2·27	3·95	20·92	6·84	1·60	4·58	6·19	1·48	3·23	2·02	5·89
Lake Superior to Tête Jaune Cache, †1,500 miles	445 05	118·25	63·74	82·59	174·11	25·84	9·25	10·80	47·87	135·07	59·11	54·75	59·09	39·01	31·52	35·49	108·46

*To be reduced by revision of location to 0 50 per 100.
†Tête Jaune Cache is about half a mile further west than the end of the 1,500th mile.

APPENDIX B.

Correspondence respecting the location of Stations, Roads, and Road-crossings.

Office of the Engineer in Chief,
(*Memorandum.*) Ottawa, April 12th, 1875.

Stations, Town Plots, Road-crossings, etc.

I desire to bring under the notice of the Government, some suggestions in connection with the survey of lands, adjoining the Railway, in Manitoba, the North-west Territories, and elsewhere.

I submit herewith a diagram, which will serve to explain:—

1. I would suggest that the most suitable points for stations, should be selected at convenient distances, say from six to ten miles apart. In selecting these points, care should be taken to have them on level, and as far as practicable, on straight sections of the Railway, or failing this, on easy curves; they should not be near the foot of long steep grades, nor on any grade exceeding fifteen feet to a mile.

The points selected should not be where the Railway is on embankment or in cutting, but where the grading necessary for station purposes, could be done at the least cost.

2. The reservation of land for stations should be on a liberal scale, say 2,000 feet long, (at all events this length in level prairie sections), so as to allow for long trains shunting and standing without interference with the road-crossings, hereafter referred to. The breadth of the station grounds need not be great, except where special provision is required for engine-shops, etc.; 150 to 200 feet on each side of the centre line of the Railway would be ample.

3. A road should be laid out all round the station ground; it would cross the Railway at two points, 2,000 feet apart; there should be no other road across the station ground, except for foot passengers.

4. Opposite and around each station located as above, a suitable area of land should be reserved for a town plot, laid out and sold as such; behind the town plot, some of the land should be laid out as park lots.

5. I would strongly advise the reduction of crossings, both *public road* and *farm crossings*, to the least possible number. Statistics show that a very large percentage of fatal accidents on railways result from road-crossings. In a new country they could be largely reduced, without any inconvenience to the public, and, at the same time, save the cost of making and maintaining them.

In order to effect the desired object, I would suggest that the farm lots between stations should all be laid out with their rear ends to the Railway line, as shown on the sketch; that a road allowance should be made on the ends farthest from the Railway, and that there should be no allowance for roads between any of the farm lots. This would render *farm* crossings entirely unnecessary, and it would throw the public road-crossings at the stations only, at which points there is always least danger, as the trains invariably reduce their speed when approaching stations.

I have drawn on the accompanying sketch, the strip of land proposed to be reserved on each side of the Railway, one mile in width. This width would probably embrace sufficient area for town plots, park lots, as well as farm lots; in connection with the latter, it might be advisable to withhold the sale of them, until all the other farm lots in the neighbourhood were taken up, and when offered for sale, special stipulation may be made for the maintenance of the railway fences, the planting of trees, or other provision to prevent snow-drifts, and also with respect to fires caused by sparks from the locomotive engines.

SANDFORD FLEMING,
Engineer in Chief.

(*Memorandum.*)

DEPARTMENT OF THE INTERIOR,
DOMINION LANDS OFFICE,
OTTAWA, 16th April, 1875.

The undersigned has the honour to submit the following remarks upon the paper (subjoined) of Mr. Fleming, Engineer in Chief of the Canadian Pacific Railway, in reference to stations, road crossings, &c., connected with the said railway.

The different points will be considered under numbers corresponding to those on the paper referred to.

1. The site of railway stations will, as a matter of course, be selected as well by engineering as by trade considerations, and will be altogether in the discretion and judgment of the engineers of the road.

2. Preservation of land for stations; form and extent thereof.

3. Roads around and crossings connected therewith.

4. Town plots.

Mr. Fleming's suggestions in regard to the above are such as recommend themselves to favour.

5. The remarks of the Chief Engineer as to the policy of keeping down the public roads and farm crossings to the least possible number, in view of reducing thereby the chances of accidents and of saving in expenditure, cannot be gainsaid; and the fact of the railway being run through territory in advance of settlement will greatly favour the carrying into effect of such policy, as settlement will naturally draw round the points which may be selected for stations.

Mr. Fleming is understood to propose that under no circumstances shall there be public road crossings, excepting at stations, which latter may be from six to ten miles apart.

The undersigned is of opinion that public crossings over the railway may be advantageously restricted, but that it would be incompatible with the public interests and convenience to carry the restrictions as far as proposed.

He thinks that, as a rule, public road crossings should be provided at points not more than three miles apart. A less number of crossings than as above would ultimately result in great inconvenience to the public, and be calculated to embarrass the sale and settlement of the lands.

Mr. Fleming's proposal, that the farm lots on each side should be laid out with their rear ends to the railway, having a road allowance in front, is a good one.

This plan would do away, altogether, with any necessity for farm crossings. The lots, however, should be at right angles to the railway, one mile deep on each side in the clear, by twenty chains frontage.

The town plots, as a rule, to embrace four of such lots, and to be laid out on a uniform plan, into building and park lots.

Mr. Fleming suggests that those farm lots lying contiguous to the railway might be disposed of on certain special stipulations—that is to say, for the maintenance of railway fences, the planting of trees, or other provision to prevent snow-drifts, and further, with respect to fires caused by sparks from the locomotive engines.

Respecting this, the undersigned has serious doubts. He thinks it would not be advisable to impose any such conditions on the sale or settlement of those lands, for various reasons—mainly, for the reason that, in his opinion, it would be impracticable to carry out such conditions, as the imposition thereof would result in a constant state of warfare and difficulty between the Government or the Railway Company and adjoining settlers.

The matter of maintenance of fences, of carrying out any provision to prevent snow-drifts by the planting of trees, or otherwise, he thinks can only be satisfactorily assumed and carried out by the Government or the Company, who would further, without there was express legislation to the contrary, be responsible for any damages caused by sparks from the engines.

The undersigned would remark that the Chief Engineer's proposals as to crossings, method of laying out farm lots abutting on railway, &c., can only apply to those parts of the Province or Territory where the line does not pass through settlements, or intersect Half-breed lands; and, further, must be subject to any legal rights of the Hudson's Bay Company respecting the one-twentieth of their lands, as allotted to them under the Dominion Lands Act.

Respectfully submitted.

J. S. DENNIS,
Surveyor General.

CANADIAN PACIFIC RAILWAY,
OFFICE OF THE ENGINEER IN CHIEF,
OTTAWA, May 6th, 1875

(*Memorandum.*)

To the
Secretary of Public Works.

On the 12th April, the undersigned submitted for the consideration of the Minister, a memorandum on the subject of the location and survey of stations, town plots, road crossings, &c., along the route of the Pacific Railway.

The memorandum alluded to was referred to the Department of the Interior.

The Surveyor General on the 16th ult., submitted some remarks on the subject to the Hon. the Minister of the Interior.

The remarks last referred to have now been transmitted to the undersigned.

In the original memorandum, the subject was divided into the following five different points, opposite each of which will be found the views of the Surveyor General.

1. The Engineer in Chief suggests that the most suitable points for stations should be selected from six to ten miles apart, and lays down certain engineering conditions to guide in making a selection.	The Surveyor General thinks that stations should be selected altogether in accordance with the judgments and discretion of the engineer of the railway.
2. The Engineer in Chief advises with respect to the reservation of land for stations.	The Surveyor General thinks these suggestions recommend themselves to favour.
3. The Engineer in Chief recommends the laying out of roads in connection with the stations.	The Surveyor General approves.
4. The Engineer in Chief recommends the reservation of land for a town plot around each station.	The Surveyor General approves.
5. The Engineer in Chief advises strongly the reduction of crossings both public and private to the least possible number.	The Surveyor General admits that the policy recommended on this point cannot be gainsaid, and the location of railway and the laying out of the land in advance of settlement will render the adoption of the policy an easy matter.
6. The Engineer in Chief suggests that any farm lots laid out on the mile strip proposed along each side of the railway should all have their backs turned to the railway with a road allowance in front, and thus render farm crossings wholly unnecessary.	The Surveyor General thinks this proposal a good one, and recommends that the farm lots should be at right angles to the railway; one mile deep on each side by twenty chains frontage.

7. The Engineer in Chief advises on account of the increased security to life and property the greater ease with which the railway will be operated, and the reduced cost in construction and maintenance, that no crossings should be laid out except at the stations.

The Surveyor General thinks that the crossings might be advantageously restricted, but a less number of crossings than one at every three miles would ultimately result in great inconvenience to the public, and embarass the sale and settlement of the lands.

The undersigned is glad to find that the Surveyor General on almost every point gives his unqualified approval to the suggestions proposed. It is only with respect to the last point that he does not fully concur.

In support of the original proposal to make provision for crossing the railway at the stations and town plots only, the undersigned would respectfully submit the following additional remarks :—

1. Every level crossing contains the elements of danger to the public using the crossing, as well as to passengers using the railway. This is more especially the case between stations where trains have to maintain a high speed. The undersigned believes he is correct in stating that more than one-half of all fatal accidents on railways occur at level road crossings. He has seen a whole train of passenger cars thrown off the track by cattle attempting to cross the line and getting amongst the wheels. Constantly, one hears of carriages or sleighs being run over, and the danger is increased in high winds, rain or snow storms.

2. Every level crossing is an element of danger from another cause, viz :—The cattle guards. As is well known, these contrivances are usually made of timber, they last but a few years, constantly require repairs, and without attention frequently become insecure. They are really worse than ordinary wooden bridges, as they are too insignificant to receive, as a rule, much attention from the higher railway officials and are often left to ignorant, sometimes careless laborers. It is for these men to report when the timbers are too much decayed to be any longer safe ; in fact to draw the line between security and positive danger and the wonder is that accidents from rotten cattle guards do not more frequently occur. Cattle guards at stations are not likely to be neglected, as they come under the eye of other officials ; besides which, trains pass stations at low speed, and in consequence the danger is much less than at other points where the speed is high.

3. In a country already settled, it would doubtless be impracticable to close up roads already in use across the line of proposed railway, but in an entirely new country, where there are no inhabitants and no roads, the settlers as they take up lots and occupy the land, would suffer very little, if any, inconvenience from the plan now proposed, and would not, in any way, feel the loss of a privilege or right which they never possessed. To them, the line of railway would resemble a river or navigable channel with landing wharves and the means of crossing at short intervals, say, wherever it was deemed advisable in the interests of all to have stations.

The undersigned respectfully submits that the settlement of fertile lands along any of the considerable rivers of the older Provinces has not been materially retarded by the obstruction which the rivers offered to free intercourse between the two sides ; nor has the want of bridges, so close as every three miles, over the water channels, to any appreciable extent embarrassed the sale and settlement of the lands, or resulted in great public inconvenience after the country became occupied. Take the large rivers, the Ottawa, the St. Lawrence, the St. John, or any of the smaller rivers such as the Otonabe, the Trent, the Grand River or, for that matter, any of the canals, say the Rideau Canal. From Ottawa to Kingston the length is 127 miles, in this distance there is on an average only one bridge to every eight miles of canal. The canal passes through a comparatively old settled country, and no great complaints are made respecting the unfrequency of the bridges.

On the railways, the crossings take the place of bridges. At each proposed station on the Pacific line there would be as many crossings for carriages as there are across the Rideau Canal in the heart of the city of Ottawa, while foot passengers would

have perfect freedom to cross almost anywhere, except when trains were actually occupying the sidings.

In view of all the advantages and the very trifling, if any, inconvenience that would result, I am confirmed in the opinion that the Government would do well to adopt the policy of making provision in advance of settlement, for stations and town plots, and of laying down a system of roads which would, as far as practicable, concentrate traffic at those points only.

The undersigned does not propose that under no circumstances, whatever, shall there be a possibility of obtaining a crossing, except at stations. He urges objections chiefly to *intermediate* level crossings; should the time ever arrive when the establishment of a road across the railway at any particular point between stations becomes so important as to justify the cost of making it, there would be nothing to prevent the inhabitants from asking and obtaining permission to bridge the railway as they would a canal or river.

The undersigned trusts that on full consideration of the subject, the Surveyor-General will waive the only objection which he has offered to all the essential points of the scheme proposed.

The undersigned views the present as an excellent opportunity, one which will never again occur, of adopting every improvement which experience may suggest, in connection with the introduction of railways into a country, and, believing that the Government views it in the same light, he has every hope that they will adopt the policy herein strongly recommended.

The undersigned would wish to add some remarks with respect to the matters referred to in the last paragraph of the original memorandum (dated April 12th), but he considers the subject herein discussed of primary importance, and the other subjects may be alluded to at another time.

SANDFORD FLEMING,
Engineer-in-Chief.

Canadian Pacific Railway,
Office of the Engineer in Chief.
Ottawa, 19th May, 1875.

Dear Sir,—I am requested by the Premier to transmit to you a list of the stations established on the line of the Railway between Cross Lake and Mossy River, and to furnish you with their names, approximate distances east and west of Selkirk, and the number of the stakes at which the centre of the stations, in each case lettered "A" on diagram of town plot, are to be placed. I also furnish a plan showing their relative positions.

You are aware that the suggestions submitted by me, in a memorandum dated the 12th April, relative to stations, town plots and road crossings have been approved, and it is the desire of the Premier that steps should be immediately taken to carry them into effect. Enclosed herewith you will find a diagram for town plots, which, in connection with the memorandum referred to, is also approved.

The diagram shows four different projections for town plots, each of which embraces the same leading features. They are designed with the view of carrying out, in the best manner, the principles laid down in the memorandum above referred to, and advocated in my letter to the Secretary of Public Works, of date of 6th May last.

The Premier desires me to say to you that he approves of the designs, and wishes you to adopt them as standards in laying out town plots around the stations on the line of the Pacific Railway. Either of the designs may, of course, be adopted or modified at your discretion to suit the circumstances of each case, the main object being to secure all the advantages of the new system referred to, in the least objectionable way.

Assuming that the red letters indicate the limits of the town plots, it is considered highly advisable that all the farm lots outside of the town plots, and within

the one mile strip on each side of the Railway, should be withheld from sale or occupation until after the completion of the Railway, and the best means of overcoming the snow difficulty in each locality be ascertained.

Yours truly,

Lt.-Col. J. S. Dennis, (Signed), SANDFORD FLEMING,
Surveyor-General. *Engineer-in-Chief.*

STATIONS.

Instructions to District Engineers and others.

For several reasons it is important that early steps be taken to select the very best positions for the Railway Stations, and that they should be located, and the gradients of the line, at and approaching thereto, finally established before construction be commenced.

In districts fitted for settlement the Government has approved and sanctioned a system of laying out lands adjacent to the line of Railway, which will render public and private road crossings unnecessary, *except at Stations.*

In these districts it is intended to reserve a sufficient area of land around each station for a Town plot, and to lay it out when required, into lots of suitable size.

Each station will become a centre of traffic for the country around, and in some cases, important towns will undoubtedly spring up. In selecting station sites, attention should therefore, to some extent, be given to the physical features of the adjacent country, so as to afford the greatest facilities for developing the resources and accommodating the business of each locality. The general interests of the railway in directness, good gradients and cost of construction must however, be considered of primary importance.

In prairie and fertile districts, the stations should not be so far apart as to leave an opening for intermediate stations at a future time. All the stations in any way desirable should be located in the first place. It is considered that the average distance between stations should be about eight miles.

In mountain and other districts, where the necessity for stations for traffic purposes will not be great, sidings where trains may cross, or engines may wood and water, will nevertheless be required,—points for this purpose may be selected about every ten miles.

The undersigned requests that immediately after a trial location be made and before the gradients are finally adopted, the District and Resident Engineers should proceed to ascertain the most suitable points for stations, reporting to Head Quarters without delay. In this matter the following rules will be observed.

1. Station sites may be considered to be at minimum and maximum distances apart of six and ten miles respectively.
2. The Station should be located on a nearly level portion of the line, if such be practicable. Where the line undulates, a summit is preferable to any other position.
3. It should never be placed, under any circumstances, on a grade steeper than 15 feet per mile.
4. It should not be near the foot of a long steep grade; a minimum distance of half a mile from the foot of the grade should be obtained, if at all practicable.
5. It should be on most suitable ground transversely as well as longitudinally.
6. It should be on a straight line, if at all practicable, so that approaching trains may be seen a long distance off.
7. It should be on ground where the main line and siding would be nearly on the natural surface, so that the quantity of work in grading would be the least possible. No borrowing should be done within the limits of the station ground.
8. The length of line to which the rules, 3, 5, 6 and 7 are to be applied, should be 2,000 feet, or as near thereto as possible.
9. The station should be at a place where a good supply of water can be had; in hilly districts a gravitation supply should be looked for.

SANDFORD FLEMING,
Engineer in Chief.

APPENDIX C.

LIST OF STATIONS ESTABLISHED BETWEEN LAKE SUPERIOR AND TETE JAUNE CACHE, IN THE ROCKY MOUNTAINS.

FIRST 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks
	Miles.	Feet.	
Fort William	0	7	Fort William is the Canadian end
Murillo	12½	384	of the St. Lawrence Navigation
Lofoden	16	474	on Lake Superior.—Lake Su-
Kaministiquia	23	581	perior is 598 ft. above the level
Finmark	32	581	of the sea.
Buda	39½	873	
Nordland	50½	944	
Linköping	60	935	
Port Savanne	70½	907	The line at Port Savanne connects
Upsala	80½	963	with Lac des Mille Lac and the
Carlstadt	89	916	Dawson route.
Bridge River	98½	944	

SECOND 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks
English River	112	919	
Martin	119	960	
Fonheur	129½	932	
Falcon	137	909	
Ignace	148	890	
Butler	155	834	
Raleigh	163	809	
Tache	173	825	
Malmkorn	181	681	
Bois Brule	190½	616	
Wabigoon	199¼	656	

THIRD 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks
Barclay	208½	652	
Oxdrift	220¾	567	
Eagle River	231	596	Bank of River Eagle.
Vermillion	240	645	On Lake Vermillion.
Gilbert	249¼	627	
Parrywood	260¾	776	
Cormack	269¼	711	
Atikameg	279	648	
Rossland	288	539	
Keewatin	297	496	At Keewatin, near Rat Portage, the line touches Lake of the Woods.

LIST OF STATIONS ESTABLISHED BETWEEN LAKE SUPERIOR AND TETE JAUNE CACHE, IN THE ROCKY MOUNTAINS—*Continued.*

FOURTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
	Miles.	Feet.	
Ostersund	306	521	
Kalmar	320	627	
Ingolf	327½	590	
Telford	339	508	
Rennie	349	459	
Darwin	359	374	
Whitemouth	368½	309	
Shelley	376	341	
Monmouth	384	290	
Beausejour	394	226	

FIFTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
Tyndall	400½	207	
Selkirk	409	154	Selkirk is on east bank of Red River; here the line connects with the navigation of Lake Winnipeg.
Korma	418	160	
Cowper	427½	121	
Acadie	438	308	
Cottonwood	446	312	
Carlyle	455	278	
Menstrie	464	275	
Eldon	473	267	
Borodino	480	264	
Grattan	488	247	
Gough	495½	245	

SIXTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
Donnaccna	503	232	
Vapna	513	229	
Cartier	518	253	Cartier is at Narrows of Lake Manitoba.
Novrad	529½	235	
Braidwood	538	250	
Speke	547	265	
Logan	555½	256	
Haywood	564	255	
Hogarth	572	258	
Poutrincourt	581	256	Poutrincourt on the west bank of Mossy River, connecting with the navigation of Lake Winnipigosis.
Vandyck	588	248	
Blackwood	596½	334	

LIST OF STATIONS ESTABLISHED BETWEEN LAKE SUPERIOR AND TETE JAUNE CACHE, IN THE ROCKY MOUNTAINS—*Continued.*

SEVENTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
	Miles.	Feet.	
Longueville	604½	375	
Sussex	613	450	
Petrovka	622	599	
Northcote	629	584	Northcote is at the northerly extremity of the Duck Mountains.
Hennepin	638	583	
Coleridge	647	621	
Erskine	654	786	
Skalholt	663½	794	
Doyle	673	865	
Livingstone	681	916	Livingstone is 8½ miles north of Fort Pelly.
Alice	687½	1,050	
Malmo	695	1,149	

EIGHTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
Morland	701	1,116	
Assineboine	712	1,111	Near Crossing of River Assineboine.
Leyden	719½	1,131	
Stopford	729	1,425	
Nut Hill	739	1,387	
Murchison	750½	1,272	
Killyleagh	759	1,226	
Thackeray	768	1,210	
Nasmyth	777½	1,205	Nasmyth is not far north of Quill Lake.
Buckstone	786	1,257	
Thorwaldsen	796½	1,231	

NINTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
Swanholm	804½	1,292	Near where the moose died
Humboldt	815	1,280	
Gotland	823	1,236	
Denholm	831½	1,260	
Baldwin	841½	1,276	
Grenoble	852½	1,219	
Finland	862½	1,124	
Roundell	869	1,100	
Saskatchewan	876½	1,049	On the easterly bank of the River South Saskatchewan.
Oldred	884	1,080	
Goulbourn	891	1,107	

LIST OF STATIONS ESTABLISHED BETWEEN LAKE SUPERIOR AND TETE JAUNE CACHE, IN THE ROCKY MOUNTAINS—*Continued.*

TENTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
	Miles.	Feet.	
Bethlehem	904	1,048	Near The Elbow of the River North Saskatchewan.
Caerlaverock	912	946	
Normanfield	924	922	
Ronaldsa	934	1,071	
Raith	943	996	
Eagle Hill	952	1,016	
Hecla	960	985	
Battleford	967	1,019	Near the mouth of Battle River (proposed Seat of Government of the North-West Territory).
Coal Brook	975	1,088	
Wolf Hill	983	1,108	
Nabikwan	995	1,189	

ELEVENTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

B	1,005½	1,249	
C	1,014	1,332	
D	1,023	1,516	
E	1,035	1,455	
F	1,045	1,529	
G	1,057½	1,505	
H	1,067	1,569	
Grizzly Bear	1,075	1,549	
I	1,088	1,614	
K	1,099½	1,644	

TWELFTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

L	1,110½	1,729	
M	1,121	1,729	
N	1,133	1,647	
O	1,143	1,691	
P	1,152	1,767	
Q	1,162½	1,877	
R	1,173	1,904	
S	1,184	1,904	
Edmonton	1,197	1,817	20 miles south of Fort Edmonton.

LIST OF STATIONS ESTABLISHED BETWEEN LAKE SUPERIOR AND TETE JAUNE CACHE, IN THE ROCKY MOUNTAINS—*Concluded.*

THIRTEENTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
	Miles.	Feet.	
Grandin	1,208	1,784	
Siksika	1,220½	1,724	
Laplaine	1,229¾	1,826	
Palliser	1,239	1,817	
Belcour	1,250¾	1,811	
Lobstick	1,263½	1,922	
Langlade	1,275	1,989	
Southesk	1,285	2,092	
Cheadle	1,296½	2,167	

FOURTEENTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

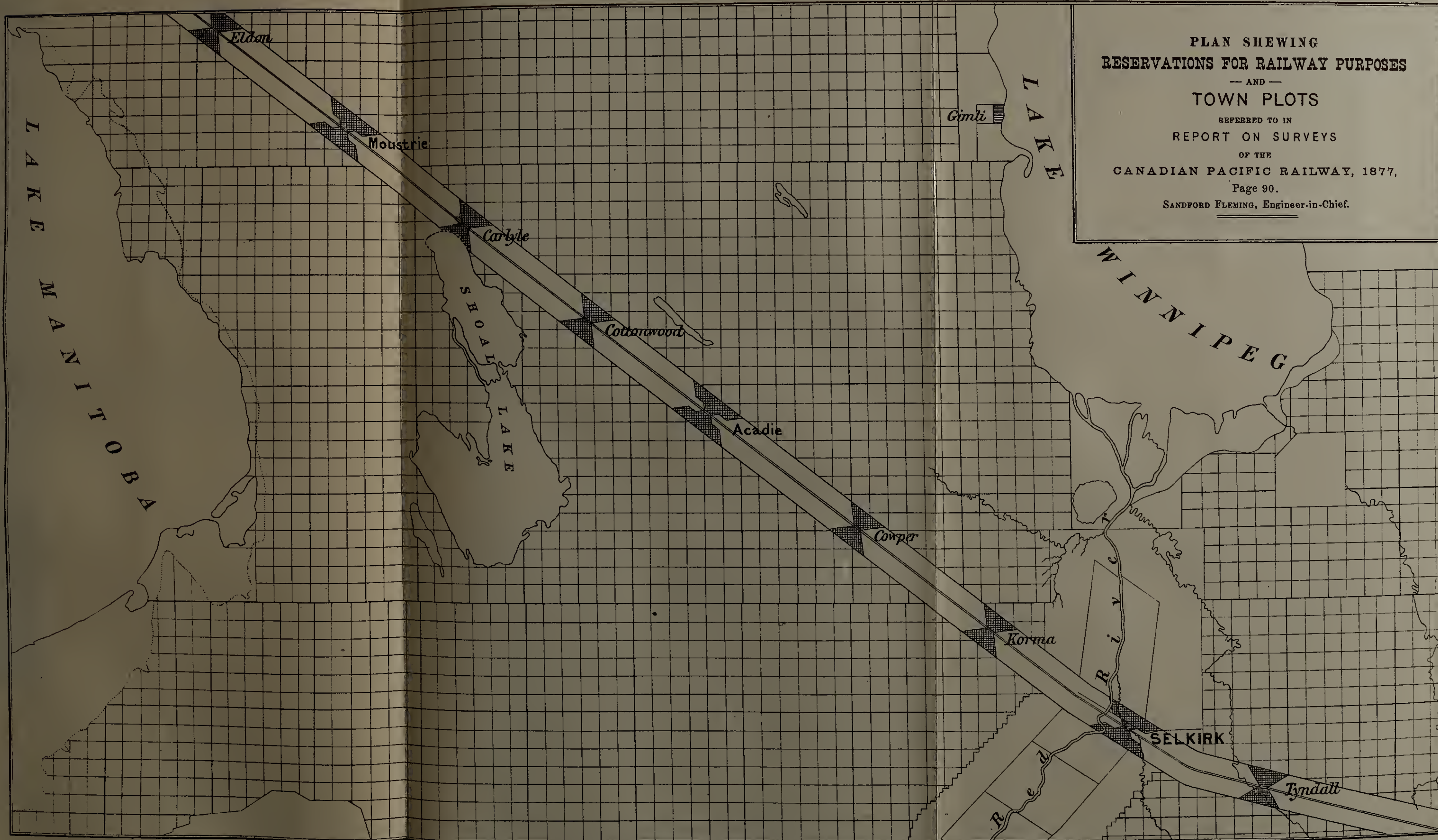
Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
Root River	1,309	2,325	
Lacombe	1,323	2,447	
Montbrun	1,332	2,412	
McLeod	1,340	2,466	Near River McLeod.
Beaver	1,351	2,804	
Vallad	1,361	2,871	
Ponoka	1,369	2,772	
Bayonette	1,381	2,630	
Hector	1,391	2,663	

FIFTEENTH 100-MILE SECTION WEST OF LAKE SUPERIOR.

Name of Station.	Distance from Lake Superior.	Height above Lake Superior.	Remarks.
Grand Portal	1,401	2,649	
Jasper	1,410½	2,647	
Miniwakan	1,419½	2,680	
Athabasca	1,430	2,743	
Myette	1,439	2,680	
Summit Meadow	1,447	3,032	The actual summit is at 1,452½ miles. It will be in a shallow cutting; the elevation will be 3,122 feet above Lake Superior, and 3,720 feet above the level of the sea.
Yellow Head	1,455	3,050	
Wastedo	1,465	2,903	
Moose Lake	1,474	2,825	
Fraser	1,481	2,813	
Grand Forks	1,492	2,334	
Tête Jaune Cache	1,500	* 1,913 / 2,190	

*NOTE.—The elevation at Tête Jaune Cache will depend on the route adapted to the coast.

SHEET No. 4.



SCALE, SIX MILES TO AN INCH.

SHEET No. 5.

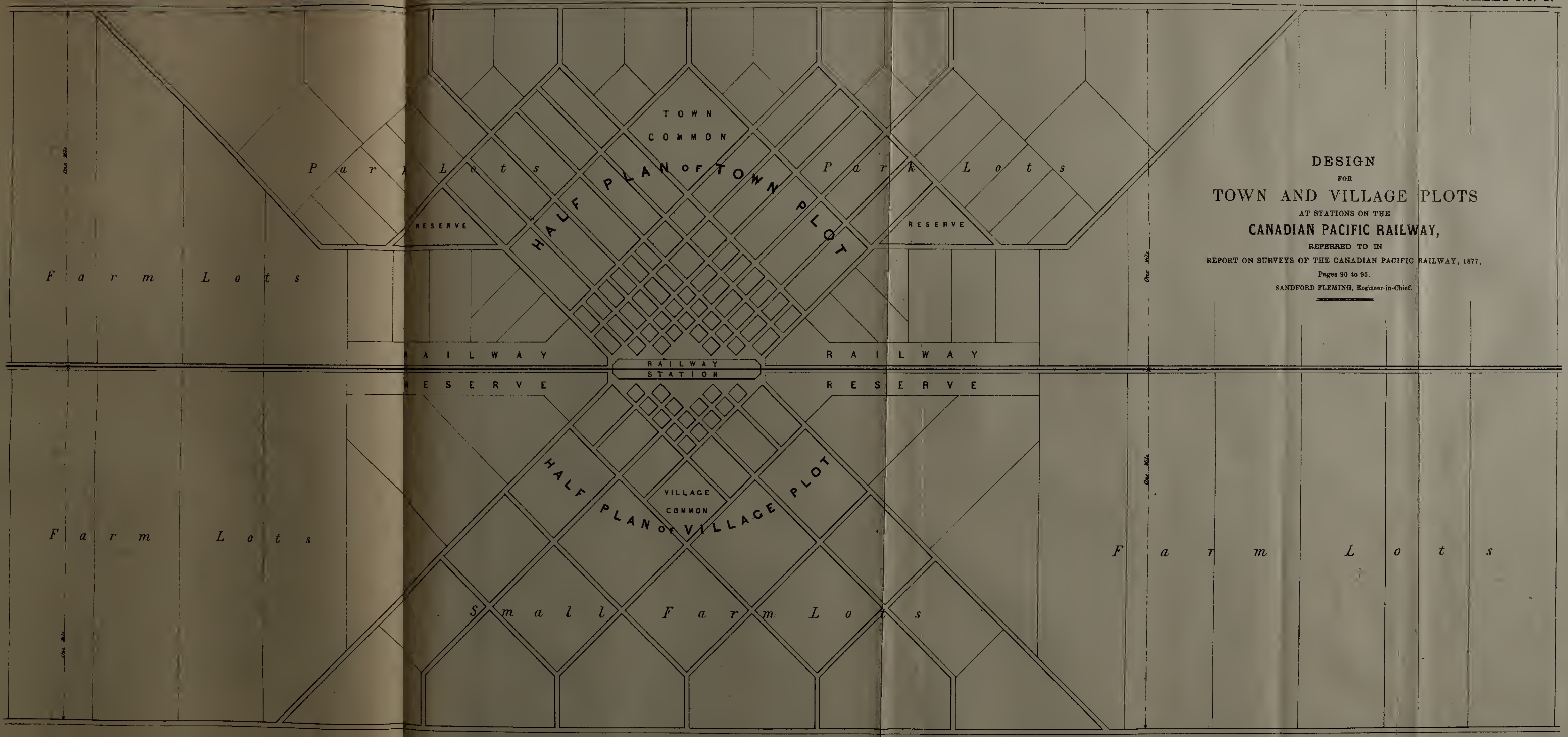


Photo Lith by the Burland Desbarats Co Montreal

APPENDIX D.

REPORT ON EXPLORATION FROM THE CLEARWATER TO THE NORTH THOMPSON, *viâ* BLUE RIVER PASS, BY JOSEPH HUNTER.

KAMLOOPS, B.C., 9th June, 1874.

SIR,—I have the honor to inform you that, as directed by Mr. Fleming's telegram to me of 28th April last, to "explore from Clearwater through to North Thompson," I left Kamloops on 2nd May, taking with me Charles Williams, Andrew Anderson, C. E. Fortier, besides "Jim" and "Dick," Indians, six weeks' provisions, thirteen mules, and two horses.

I reached the crossing on the North Thompson, six miles below the mouth of Clearwater, on the 5th, and the same day, crossed animals and supplies. I decided on taking Mahood's trail from here to Canim or Mahood Lake, thence north-east to the line of last autumn's exploration, following that line to Clearwater. I took this route from having received unfavorable information in regard to the nature of the trail up Clearwater, and the difficulty of crossing the stream from Mahood Lake at a high stage of water.

We were engaged most of the 7th in finding Mahood's trail, and in repairing it along the soft ground near the crossing. We started on the morning of the 8th, and found the trail very much out of repair. Most of the bridges were either afloat or entirely washed away. Our progress was consequently slower than I expected, and it was not until the evening of the 9th that we came in sight of Canim Lake. Next morning, instead of following the trail onward to the soft ground in the valley, I struck east, on good firm ground to Canim River, which I reached half way between Canim and Mahood Lakes. Next day, I followed the river down (on the trail cut by Mahood's party, 1872,) to Mahood Lake, with the intention of crossing not far from the head of the lake. I found it impossible to either swim the mules or cross the supplies, the river being too swift and rough. I therefore had a raft constructed, capable of taking seven animals at one load, and, by this means, crossed the head of the lake. We had everything across at dusk on the 12th. Once across this lake, I began to suspect, from the appearance of the mountains along the south side, that the exploration of last autumn had not been carried so far eastward as was supposed, and that some other stream must have been mistaken for Clearwater. A certain unmistakable double peak bore from the last camp, (No. 12) eastward of Jarvis's exploration a little east of south. This peak I recognized at once.

Acting, therefore, upon the above supposition, instead of striking N.E. as I had intended, I resolved to follow up a large stream emptying into Mahood Lake about a mile from its head, and evidently running in a S.E. direction. At noon of the third day, 15th, we arrived at Camp No. 12, (Jarvis's exploration,) having travelled about twelve miles in a bearing of north 25 ° west. This mistake could not possibly have been made by any one who had been along the Mahood Lake Valley, as the mountains on that lake once seen can be easily recognized afterwards.

At Camp 12, (Jarvis's,) I had to stay for a day and a-half, on account of the serious and almost fatal illness of Dick, the Indian.

On the 17th we left Camp 12, the barometer indicating 32.80. That day we travelled up the valley of the east branch of River Deception, six miles to my Camp No. 1, 3,500 feet. At three miles we crossed an Indian trail, which Jim informs me leads to Clearwater Lake, and at four miles crossed another well cut out trail, leading also to the head waters of the Clearwater.

From Camp No. 1 to No. 3, about due east, total distance 19 miles, the valley rises gradually to 3,800 feet. The centre in some places is wet and swampy, and generally covered with scrubby black pine, but the hill sides sustain a full growth of the finest timber, Douglas pine, spruce and cedar being the varieties most common.

I had to send the pack train back from Camp No. 3, on account of the absence of feed and the rough nature of the valley, which from here to the summit is covered with volcanic rocks, somewhat similar to the formation near the summit on the Howe Sound Route. In this instance, the surface is not quite so rough and irregular, the rocks are smaller in size, and the volcanic action seems to have been more intense. Dick had another severe attack of illness, and I had to send him back by the train. After leaving a small cache of provisions to fall back upon in case of necessity, I with one white man and an Indian, all well loaded, went ahead. The same day, (20th) the Indian deserted us and went back. C. E. Fortier and I took as much of his load as we could, and that day made Camp No. 4; altitude, 4,100; total distance from River Deception, 25 miles. The centre of the valley here is higher than at the sides by about 100 feet, and opposite here also a not unfavourable looking valley comes in from the north-east, which at 10 miles up seems to turn well to the eastward, towards Clearwater. Down this valley runs the main stream, and it is just possible that a pretty low pass might be found from the head of this stream to strike Clearwater higher up than where we crossed.

On the 21st we had travelled about two miles when we came to the end of the volcanic formation, and noticed the water running eastward. The descent into the valley of Clearwater from this point was rapid. Following down a pretty large stream we came, in five miles to where it turns southward, and probably falls into the stream from Mahood Lake, not far from its east end.

From the western slope of the Clearwater Valley, a good idea can be formed of the country below and also of the opposite side.

Along the centre of the valley runs a low mountain or back-bone, separating the stream down which we had been travelling from the Clearwater, and terminating about two miles south of our line of travel. On the opposite side, and about due east, the high range of mountains running north and south, in which Raft and Mad Rivers have their sources, seems to terminate or break abruptly, and at its northern limit there seems to be a pass eastward, not lower than 4,500 or 5,000 feet. Bearing North 60° east a favorable looking pass is seen, which seems to suddenly turn westward, and have its outlet into Clearwater Valley at the back of a small round mountain. This is the only practicable looking pass which could be seen, and is the one which I resolved on taking towards the North Thompson.

We reached Camp No. 5—3,250, in nine miles from Camp No. 4 on summit—having descended in that distance 850 feet.

On the 22nd we reached Clearwater, in four miles; altitude, 2,500 feet; total distance from River Deception, 38 miles. The travelling to-day was of the most tedious and difficult description—by a succession of benches, over piles of fallen timber, across cedar swamps and through tangled thickets of ash, hazel and willow. Clearwater is here a swift shallow stream, 400 feet wide, running a little east of south with high benches on each side.

The result so far is:—

From Camp 12, Jarvis exploration, on River Deception, altitude 3,280 feet eastward to summit, altitude 4,000 feet—27 miles, rise 720 feet.

From summit, at 4,000 feet, to Clearwater, altitude 2,500 feet—13 miles—fall 1,500. The general course being nearly due east, and the ground, so far, being generally hard and firm.

On Saturday, the 23rd, we made a raft and attempted to cross the Clearwater,

but failed, and it was not till the evening of the 24th, after drifting down stream for a considerable distance, that we succeeded in reaching the eastern bank. On 25th, travelled north 60° east, in order to strike the valley before alluded to, as seen from the west, but, after travelling six miles, discovered it was only a ravine running into the mountain, and at 3,400 feet, eight miles, had got on the west side of the valley of a stream running south 70° west, and falling into Clearwater, I should judge, about three miles north of the valley of Mahood Lake. The divide from the ravine before spoken of into the valley of the stream which, for convenience, call Murtle River, is not over 3,400 feet, nor between Murtle River and Clearwater, to the south, does any part seem of greater altitude. Camp 8, eight miles from Clearwater, on a course of north 60° east, altitude 3,400 feet.

We kept along the valley of Murtle River up stream, on a course north 80° east, to Camp 9, by a small lake, a mile long by half a mile wide, 15 miles from Clearwater. Altitude, 3,700 feet. I could hear the river to the east, and in the evening started towards it, but darkness coming on, I was compelled to return to camp. The valley here is about a mile wide, and the mountains on each side neither high nor rough.

From Camp No. 9 we travelled north 70° east, over almost level ground. In three miles we struck the river at a point where, after tumbling through a canyon for half a mile, it falls 35 feet perpendicularly.

From the head of the canyon to Camp 10, 2½ miles, total from Clearwater 21 miles—altitude 3,700 feet—the river is from 175 to 200 feet wide. At Camp 10, where it has become a lake, one-fourth of a mile wide, we crossed on a raft, and travelling down a fine wide valley, due east, for five miles, reached a lake at 3,700 feet, the same altitude as Camp 10. I soon discovered that we had crossed an arm of this (Murtle Lake) early in the morning

Murtle Lake, undoubtedly one of the finest sheets of water in British Columbia, is ten miles in length, north and south, by seven miles in width. It is enclosed on the east by low green hills; on the north the mountains are bold, high and rugged. On the south, the most important in case a line of railway should come this way, the mountains are steep but not rough, and generally keep well away from the lake, leaving a margin of hard, firm, level ground along the shore. The atmosphere here is thin and transparent; the water of the lake is fresh, clear and deep. Two small streams enter the lake from the east, but the main feeders come from the mountains to the north.

Having crossed by a raft on the 29th, we took the valley of the stream further to the south, but soon found it turning south-east, and returned to Camp 12. Here we noticed recent signs of horses, but we searched in vain for any trail to this neighborhood. An old wigwam, a cache, a fishing spear and several paddles were found, showing that Indians must frequently visit here.

On the 31st we took stock of our supplies, and discovered that we had just enough left to take us back to our cache, providing no delay took place in re-crossing the Clearwater. With reluctance, I resolved to begin our return next day. As a last attempt, however, I climbed the mountain to an altitude of 5,000 feet, went eastward along the ridge for about eight miles, and there, from a tall tree, could see, about forty miles east, a high range of mountains stretching north and south, which it was impossible for the small stream running in the valley below to drain, I therefore concluded that there must be a divide not far up the valley, and that the high mountains must be on the east side of North Thompson. Could we get there in four days we would be safe, for then we would not be more than a few days travel from a small cache of supplies which I left on my first trip up the North Thompson, not far from the mouth of Devil's Canyon; besides, we might meet our pack train, which, in case of spare time, I had ordered up river to meet us. I resolved to make the attempt.

Early on the morning of the 31st we left Camp 12 on Murtle Lake, and, travelling north 80° east, up a favorable valley for five miles, reached the divide at 3,800 feet; total from the Clearwater 38 miles. Five miles farther on we camped at 3,650 feet. Up to this point (Camp No. 13) there are no great obstacles in the way, at least from

Murtle Lake. From Camp 13, however, the mountains begin to close in, and the stream to fall rapidly through a canyon, as much in some places as 75 feet in 200 yards. For five miles this canyon continues, the mountain rising from its edges almost perpendicularly. At five miles from Camp 13 the canyon suddenly widens out into a fine level valley. At the same point, a stream, much larger than that down which we came, comes in from the north-west. Here I first recognized the valley of Blue River, and the stream last referred to as that which I had explored on a former occasion. At seven miles, Camp No. 14, altitude 2,700 feet, we had thus descended, in seven miles, 950 feet. On 2nd June, following the river north 75° east, through the flat alluded to in a former report, we crossed the line of the V Division, near peg 1,037, bench mark 423.34, my barometer indicating 2,400, and camped on the North Thompson a quarter mile below the mouth of Blue River, having travelled that day ten miles. Next day at dark we reached the cache of supplies, and on June 4th met our pack train and the M division forty miles above Clearwater, Mr. Jarvis having started up that river on 31st May. My men, whom he met at the crossing of the Thompson, gave him all the information they could.

From Clearwater to North Thompson we have:—

Clearwater, altitude 2,500 feet; to summit, altitude 3,800 feet, north-easterly 38 miles; rise, 1,500 feet.

Summit, altitude 3,800 feet; to Camp 14, altitude 2,700 feet, easterly 12 miles; fall, 1,100 feet.

Camp 14, altitude 2,700 feet; to mouth of Blue River, altitude 2,400 feet, 10 miles north-east; fall, 300 feet. Total distance from Clearwater to North Thompson 60 miles.

The weather during the whole trip was very variable, the altitudes are consequently not to be too much relied upon.

After seeing the pack train safely across the Thompson, on the 7th instant, I took to a raft by which I reached Kamloops on the evening of the 8th, when I received your letter 27th May, to which I paid immediate attention.

It is not my purpose to offer any opinion or make any suggestions as to the possibility of constructing a railway on or near this line of exploration, my object being to furnish you with information sufficient to enable your better judgment to decide that point. I would only remark that if this route shall be deemed impracticable, and a line still desired between the Fraser River on the North and the Mahood Lake Valley to join the North Thompson and the Cariboo Waggon Road, it must be sought for to the north of the line just explored, as I am well satisfied no practicable route exists to the south that is not already known.

I am,

Your obedient servant,

JOS. HUNTER.

To Marcus Smith, Esq.,

Deputy Engineer in Chief, B.C.

APPENDIX E.

REPORT ON EXPLORATIONS ACROSS THE CASCADE MOUNTAINS BY THE SIMILKAMEEN AND TULAMEEN VALLEYS, BY MESSRS. JOHN TRUTCH AND H. J. CAMBIE.

Hope, B.C., 1st July, 1874.

Sir,—I have the honor to report that, in accordance with your instructions, I joined Mr. Cambie at New Westminster for the purpose of making some explorations of that portion of the Cascade Mountains lying between the southern boundary of this Province and the River Fraser, with a view to ascertain whether any suitable pass for a railway exists between the country east of the Mountains and the valley of the Lower Fraser; and more particularly in regard to the head waters of the Skagit and Coquihalla Rivers, to which allusion had been made at a public meeting held in New Westminster some time in May last, as offering the desired facilities for railway construction.

After proceeding to Hope, where we engaged the services of an Indian guide named Satcher, who had been particularly recommended as being well acquainted with the passes we were to explore, we started on the 2nd of last June, and followed the pack-trail to the Similkameen as far as Cedar Camp, on the Skagit River, a distance of some 30 miles from Hope.

The first 25 miles of this trail—to the River Skagit—was constructed for a waggon road, which, however, is now much overgrown in places, and narrow, from the cribbing and embankments having slipped away. For the first five miles the road follows the left bank of the Coquihalla River, along steep side hills. It then takes up a tributary named the Nicolaume, which it ascends to Beaver Lake, the summit between Hope and the Skagit, and distant 12 miles from the former place—the elevation being 2,150 feet above the sea. The descent to the Skagit, which is reached at 22½ miles, is much less abrupt, the height at the junction of the Sumallow with that stream being 1,900 feet. The trail then follows up the right bank of the Skagit for seven miles, to Cedar Camp, the elevation of which is 2,530 feet. At this point it leaves the Skagit and ascends a tributary for 13 miles, when it gains the summit of the Cascades at a distance of 43 miles from Hope.

At Cedar Camp we divided our provisions, and, leaving half in charge of one man, proceeded in a general south-easterly direction up the main river, now reduced to a width of 120 feet. In half a mile we found the river issuing from a narrow canyon with precipitous walls of rock 200 feet in height. Passing round this obstruction, along steep side-hills, for another half mile, we again came to the river, which we followed to a point where it makes three forks, at four miles from Cedar Camp, in which distance the rise of the river was 600 feet. The left and right-hand branches, the Indian said, were valueless, coming out of high mountains; we therefore continued to follow up the middle or main stream, now only 80 feet wide, passing numerous small feeders on our way. At 7½ miles the river, 30 feet wide, turned abruptly to the south-west, through a heavily-wooded narrow valley, which evidently rose rapidly. Here we left the main stream and followed a small branch up a valley which soon widened to half a mile. The timber, which, from Cedar Camp had been green, with a dense undergrowth, was now burnt, a few scattered logs only lying on the ground. In two miles after leaving the main stream, the branch we were following ceased to run, and in another half mile we struck a large stream 30 feet wide, coming from the south-west, and now taking a general course to the east. This was a branch of the South Similkameen. We had thus gained the summit of the "South," or "Allison" Pass, which proved to be 4,400 feet above sea-level, the rise in 16 miles, from where we first struck the Skagit, being 2,500 feet.

After ascending one of the mountains overlooking the Pass, we followed the Similkameen for five miles, to its junction with another branch coming from the south and west, down which a trail from Chilukweyuk had been made by the Boundary Commission in 1859, the two branches forming a large river flowing in a wide bottom, with cottonwoods, &c. The descent from the summit being only 450 feet, it was evident that nothing could be hoped for from assending this branch of the Similkameen, which, besides heading on the boundary, has its sources within a few miles of the Skagit, and must, therefore be an enormous height above it.

Had the Pass just described been more favourable, it had been our intention, after returning to Cedar Camp, to follow down the Skagit some eight miles below the mouth of tho Sumallow, and then endeavour to cross into the Valley of the Chilukweyuk, and follow that stream to the Fraser, as the route we had taken from Hope to the Skagit was manifestly impracticable for a railway; the rise of the Skagit itself, however, being so great we did not consider it necessary to expend further time in exploring this line.

Returning to Hope for a fresh supply of provisions, we started again up the River Coquihalla, the main facts respecting which had been already obtained, a traverse and profile, with report, having been made by Mr. Dewdney, under my direction, in the spring of 1872.

Our attention was directed, in the first place, to an examination of the different streams running into the Coquihalla from the eastward, with a view to discovering whether it was possible to obtain any pass to the head waters of the Tulameen. In this we did not meet with any success, as all the valleys rise very rapidly, heading in high mountains.

We then examined the valley of the Coquihalla itself more carefully, to see whether we could distribute the rise, by making use of side-hills, so as to lengthen the line, and improve the steep gradients shown in the section of 1872; and we think that this could be done, but that it would entail heavy work for the first 20 miles from Hope, and extremely expensive and troublesome construction for the rest of the way to the summit, as the side-hills are very steep and rocky, and subject to slides of snow, which bring down timber with them. It is scarcely necessary to add that any definite information on this subject could only be obtained by a careful and detailed survey.

I am, Sir,

Your obedient servant,

JOHN TRUTCH.

Marcus Smith, Esq.,
Deputy to the Engineer-in-Chief,
Canadian Pacific Railway.

My opinion regarding the passes explored by us completely coincides with that expressed by Mr. Trutch in the within report.

H. J. CAMBIE.

APPENDIX F.

REPORT ON SURVEYING OPERATIONS IN THE MOUNTAIN REGION DURING THE YEAR 1874, BY MARCUS SMITH.

OTTAWA, April 15th, 1875.

SIR—After the Report of January, 1874, was sent in, it appeared necessary that examinations should be made in the following sections:

1st. From the Valley of the North Thompson, *via* Blue River to River Clearwater, thence to Lac La Hache and River Fraser.

2nd. From Tête Jaune Cache, across the mountain chain, to Lake Clearwater, and thence in a westerly direction toward the Homathco Pass.

3rd. From Tête Jaune Cache, down the Valley of the River Fraser, to Fort George.

4th. From Fort George across the Chilicotin country to Lake Tatla and the Homathco Pass.

5th. From Yale northward through the canyons of the Lower Fraser.

6th. From Yale to Burrard Inlet.

7th. From Dean and Gardner channels across the Cascade Mountains to the interior of the country.

8th. From Fort George westward through the unexplored region to the chain of mountains along the coast.

9th. From the North branch of the River Fraser across the Rocky Mountain chain by the Smoky River Pass.

The first and second sections relate to Route No. 5 of the report of January, 1874, and as the result of an examination of these would determine whether it might be necessary to proceed with the third and fourth sections, which relate to Route No. 6, a telegram was sent on the 20th of March to Mr. Hunter, a member of the surveying staff, resident in Victoria, to go and examine the first section and report the result with the least possible delay.

An efficient staff was then organized for the purpose of prosecuting the surveys, and put under my charge. We left Ottawa on the 23rd of April, and arrived in Victoria on the 5th of May.

Mr. Hunter had, in the meantime, made an examination of the Valley of the Blue River, following up the north fork, which was found to be impracticable; and you had telegraphed him to go to the point, east of the River Clearwater—to which his explorations from Lac la Hache had been carried in 1873—and to continue the examination eastward to the valley of the North Thompson. He had not returned from this second expedition when we arrived in Victoria.

I then formed three Divisions, M, N and X. The first, with Mr. E. W. Jarvis in charge, left Victoria on the 15th of May for Kamloops, where they wonld arrange a pack train of horses and mules and complete their supplies.

Mr. Jarvis had instructions to send his Division up the north branch of the Thompson to the mouth of the River Albreda, while he, with a small party, should examine a line up the valley of the Clearwater, to the head of Lake Clearwater; thence across the divide to the Cariboo branch of the North Thompson, and rejoin his Division at the mouth of the River Albreda. It was expected he would meet Mr. Hunter on the way, and learn from him the result of his examination of the line between Lac la Hache and the valley of the North Thompson. Comparing this with his own line he was to commence an instrumental survey of that which appeared the most favourable. But if both lines should appear unsatisfactory, then he was to go on with his division to Tête Jaune Cache and make an instrumental survey down the valley of the Fraser to the Grand Rapids.

Division N left Victoria on the 19th of May with Mr. H. P. Bell in charge, who had instructions to proceed to Fort George and make an instrumental survey from that point eastward, across the north end of the Cariboo range, to strike the Fraser valley near the Grand Rapids; thence up the valley till he met Division M coming down.

Mr. C. H. Gamsby, in charge of Division X, left Victoria on the 19th of May, for Lake Tatla, at the head of the Homathco Pass, from Bute Inlet through the Cascade Mountains, with instructions to commence an instrumental survey from a point on the line surveyed in 1872, on a north-easterly course toward Fort George.

About this time, I received several communications from New Westminster respecting the reported discovery of passes leading through the Cascade Mountains from different points on the River Fraser; more especially the Allison Pass from Fort Hope, by the head waters of the River Skagit on the western side of the mountains, to the south branch of the River Similkameen on the east side.

As a practicable pass in that neighbourhood would be of the utmost importance in affording a possible means of avoiding or reducing the chief difficulties of the Route No. 1, I immediately gave instructions to Messrs. J. Trutch and H. J. Cambie to form an exploring party, and examine, in company, every pass they could find or hear of between the Coquihalla and the American boundary line; and to engage for their assistance some of the most intelligent Indians accustomed to hunt in these mountains.

General Examination of the Coast north of Bute Inlet.

All the parties at my disposal were now in the field except a small division for the exploration from the Dean and Gardner channels, across the Cascade Mountains to the interior of the country, which Mr. Horetzky was placed in charge of.

It had been arranged that Mr. Richardson, of the Geological Survey, should act in concert with this party, and he had accordingly left a fortnight before, in a small hired sloop, taking with him the necessary men and stores.

I had proposed to make a general examination of the coast, and to take passage in one of H. M. gunboats, which had been obtained for the purpose of assisting and protecting the surveying party, should the Indians show any hostility or offer any obstruction to their operations. But, at the last moment, some difficulty was raised as to accommodation by the officer in command of H.M. gunboat "Boxer," which had been ordered on this service by the senior officer in command of the Station.

This threatened delay I could not afford, as I had made engagements to meet the several Divisions at stated times and places during the season. I was, therefore, fortunate in arranging with Mr. Charles, the Chief Agent of the Hudson's Bay Company at Victoria, to limit the next trip of the Company's steamer "Otter" northward, to Fort Simpson,—she being ready to start in a few days,—and to take myself and party to all points required for the surveys.

I advised you of this by telegram, and it was then further arranged that the "Boxer" should accompany us as convoy.

Our party consisted of Mr. Horetzky, Mr. Seymour, Deputy from the Indian Department, and myself. We left Victoria, in the "Otter," at 5 a.m., June 4th, arriving at Nanaimo at 2:30 p.m. We took in coal and left at 5.30 the same evening. As we passed Departure Bay, three miles north of Nanaimo, we saw the "Boxer" lying at the coal wharf.

June 5th.—Having steamed all night we passed Seymour Narrows soon after sunrise this morning. The western coast of Vancouver Island, from this point to Esquimalt, is described in the Report of January, 1874. The belt of flat land lying between the foot of the mountains and the Straits of Georgia, from Nanaimo northwards, ends here, and the mountain slopes come down to the water's edge, in a steep, irregular line, broken at intervals by rugged cliffs, projecting into deep water.

This character of outline continues to the end of Discovery Passage; but after reaching Johnstone Strait, the slopes of the mountains rise, generally at an easier

inclination, to a height of one to three thousand feet, and are covered to their summits with a dense growth of fir, spruce and cedar.

The mountains in the interior of the island rise to a much greater altitude, with summits of bald rock, in some places covered with snow. Victoria peak is more than 7,000 feet above sea level.

Johnstone and Broughton Straits are bounded on the north by a number of islands, and a promontory or spur from the mainland, the channels between which connect with fiords, or long. narrow arms of the sea, some of which pierce to the core of the Cascade Mountains.

These islands and headlands are masses of rock, partially exposed, but for the greater part covered with a thin coating of vegetable soil, supporting a dense growth of spruce, fir and cedar, from their water base to their summits---rising from a few hundred feet to an altitude of three to four thousand feet above sea level. In the ravines and flats the trees attain a large size and are valuable; but by far the greater proportion of those on the mountain slopes are small, stunted and worthless.

On reaching Beaver Cove, on Broughton Strait, the mountain slopes on Vancouver Island begin to recede from the water, and there is an interval of table land containing extensive beds of coal, some of which have been worked by the Hudson's Bay Company. This flat is, in some places, of considerable breadth, and extends as far as Fort Rupert, on Beaver Harbour. Farther west, the mountain slopes touch the waters of the Goletas Channel throughout its entire length, but the range rises only to a height of from 500 to 1,400 feet.

Near the 127th degree of west longitude the River Nimpkish enters Broughton Strait. This river receives the overflow of Lake Karmutsen and several other smaller lakes, lying in a valley of considerable breadth in which there is some good land.

This would probably be a favourable route for a road or railway across Vancouver Island to Kyuquot Sound, on the west coast of the island.

Opposite the mouth of the river lies Cormorant Island, on the south side of which there is a beautiful little harbour called Alert Bay and an Indian village, the residence of a portion of the Quokolt tribe, numbering about two hundred.

Here we saw a very fine canoe, sixty feet long and eight feet in beam, made out of a solid cedar or cypress tree. It came from Nootka, on the west coast of Vancouver Island.

The Indians are very skilful in modelling their canoes. Having selected a sound tree and cut it to the desired length, the outside is first shaped, then the tree is hollowed out till the shell is of the proper thickness; this is done with a tool resembling a grubbing hoe or narrow adze, with a short handle, and used with one hand. It is than nearly filled with water, which is heated by throwing in hot stones; the canoe is then covered with canvass to keep the steam in, this softens the timber and the sides are distended by cross struts to the desired breadth at the centre and tapering towards the ends in lines of beautiful symmetry. It is finished off with a highly ornamental figure-head, and the bulwarks are strengthened by a fancy covering board.

We arrived at Fort Rupert about 5 p.m., went ashore and visited the Hudson's Bay Company's Fort, which is one of the few remaining in a complete state, as originally built, when the Indian was master of the country. The old pallisading, fifteen to twenty feet high, is yet intact, and the old storehouse, homely but substantial, is still standing.

We were kindly entertained by Mr. Hunt, the officer in charge of the station, who shewed us his well-kept garden, through which runs a clear stream of water, bordered with a hedge of hazel, its wooden walls being adorned with ivy, honeysuckle and other creepers.

We next visited several of the houses of the Indian village, which cluster round the fort, and are inhabited by the main body of the Quokolt tribe, numbering about three hundred souls.

These houses are generally large, some of them forty to fifty feet square; rudely but substantially constructed with a frame of heavy timbers, panelled and covered with

cypress planks, two to five feet wide and one to two inches thick. These are prepared with great labour by first splitting the huge trees into rough planks, then smoothing the surface of the latter with the same tool they use in hollowing out their canoes.

One house often contains several generations of the same family; those we visited were comparatively clean and well swept, with a comfortable fire blazing in the centre, and beds of furs and blankets ranged round.

Most of the Indians were out hunting and fishing, but Mr. Seymour gave handkerchiefs, tobacco, &c., to the old chief and the few others present, with which they were much pleased.

At daybreak next day we found we were crossing Queen Charlotte Sound, and exposed to the swell of the Pacific Ocean; but the weather was calm, and the lowering gloom of the last two days had brightened into sunshine.

By noon we had entered Fitzhugh Sound, and the view around, agreeable at first, soon became monotonous and wearisome. On each side of us lay an endless line of hills, with undulating crests broken at intervals by deep ravines; the higher ranges would occasionally recede from the channel with a low range of hummocky hills intervening, the whole densely covered with spruce, firs and cedars.

Entering the Plumper Channel, we soon passed the end of the Lama Passage and reached Bella Bella, Campbell Island. Here the Hudson's Bay Company have a trading post, and the Quokolt Indians a village and fishing station. Leaving the Gunboat Channel on our right, we rounded the north end of Campbell Island, and entered the Seaforth Channel on a westward course. In two hours more we were in Millbank Sound, and got fairly into Finlayson Channel before night set in.

The islands around Millbank Sound are generally low, intersected with broken ranges of hummocky hills covered with firs and cedars. Over the low hills and far in the distance rose a bold range of dome-shaped snow-clad mountains; apparently crossing the heads of the Dean and Gardner Channels, not less than seventy to eighty miles from us.

June 7th.—Having steamed all night, through the Finlayson Channel, Hickish Narrows, Graham and Fraser Reaches and the Ursula Channel, we passed the large island in Gardner Channel shown on Vancouver's chart but not named, and found the sloop "Triumph," with Mr. Richardson and the men and stores on board. We took the sloop in tow till we reached the mouth of the Kemano River, which enters the north side of the channel about twenty-five miles from its head, where we left the party to commence the survey.

The Gardner Channel from the island up to this point is from one to two miles in breadth, and of great depth; hemmed in by mountains two or three thousand feet in height, covered to their summits with timber of little value. As we ascend the channel the rocks become more exposed and rise to a greater altitude, the slopes are steeper, and for long stretches perpendicular cliffs abut on the channel. The Kemano Valley is a half to three-quarters of a mile wide where it joins the channel, and covered with fir and cedar trees of good size. The river is small, but navigable for canoes ten miles from its mouth. From this point upwards, the shores of the channel become more irregular in outline, and the mountain slopes rise more abruptly; they are partially covered with timber to a height of about 2,000 to 3,000 feet; above which the rocks are bold, scarred and weather stained, and the deep gulches that separate the mountain domes are filled with immense glaciers. We were evidently approaching the core of the Cascade chain. The mountains became more gloomy and sterile, rising 6,000 to 8,000 feet, and being capped with permanent snow. At the head of the channel there is a large flat of sand and detritus, which is only partially covered at low tide; and with shoal water for half a mile or more; there it shelves down abruptly into very deep water, so that the only anchorage is on the face of this incline and there is very little space for a vessel to swing. Kitlope River enters the head of the channel from the east, but was hidden from our view by a rocky bluff or spur 300 to 400 feet high and half a mile long, shooting out from the south side and partially blocking up the mouth of the valley. A smaller stream comes down from the north through a deep and narrow ravine and enters the Kitlope near the

head of the channel. The Kitlope River itself is about eight hundred feet wide at its mouth ; its south bank is the bold rocky slope or cliff above-mentioned, the base of which is washed by the river for about two miles. The opposite side is a low grassy flat about three hundred yards wide ; a slough or branch of the river has cut through the upper portion of this, which we followed up over a mile, passing the nose of the mountain on the north-west side. A little further on we rejoined the main river, which here makes a sharp bend across the valley, and washes the base of the cliffs on the north-west side for half a mile. This point is about four miles up the river, where it is fully five hundred feet wide, the valley being a half to three-quarters of a mile in breadth. About a mile beyond this, the river trends with an abrupt curve to the south-east, round a mountain spur, behind which lies an Indian village.

These Indians are an outlying branch of the Tchinsains and their dialect is so mixed up with that of the Bella Coola's that Mr. Duncan had difficulty in conversing with them. The Gardner Channel has great depth of water throughout; there are few sheltered places where a large vessel could anchor and lie in safety, and for long stretches the shores are rocky cliffs where no landing could be effected, and they are generally impracticable for a line of railway.

June 8th.—We started down the Channel, and after passing Stainforth Point steamed up the North Branch to its junction with the Douglas Channel, the head of which we reached about noon, and stopped opposite an Indian village, to which we sent a message for the Chief to come on board.

The Kitimat Valley, at the head of the Channel, appears to be three to four miles wide and very low; it stretches away to the north, affording an easy route to the Skeena River. On the west, the hills rise to an altitude of 1,000 to 3,000 feet, covered with the irrepressible fir. On the east side the hills abutting on the Channel are of similar character; but through low gaps in the range we caught glimpses of higher mountains capped with snow, leaving scarcely a chance of a practicable route for road or railway through the Cascade chain to Lake François or the River Nechaco.

Several Indians now came on board with their Chief Tsin-ah-hay. These are part of the Tchinsain tribe, as were also those at the head of the Gardner Channel; but the main body is at Metlahkatlah, where Mr. Duncan guides both their spiritual and temporal affairs.

It was fortunate this gentleman was a passenger with us, as he talked to these Indians in their own language, which he speaks fluently, and insured for us a good understanding with all the Indians on the coast north of the Dean Channel.

After some talk and the usual presentation of gifts, we steamed down the Channel, rounded the cape, and got well into Grenville Channel before night set in.

June 9th.—We reached Port Essington, a Hudson's Bay Company's Post, on the estuary of the River Skeena. The shores of this part of the river are very irregular in outline, and there are no alluvial benches; the slopes of this hill rise from the water more or less abruptly to a height of one to three thousand feet.

Passing between Kennedy Island and Perry Point, we touched at a point called Woodcock's Landing, then ran along the coast till we reached Metlahkatlah Bay, which we entered, and dropped anchor within three hundred yards of the principal village of the Tchinsain Indians, under the rule of Mr. Duncan.

The mission house stands on a knoll about 100 feet high close by the shore; behind this is the new church which is being built by the Indians and is now nearly finished; from this the village extends in two wings, following the sweep of the shore line.

This church is a substantial frame building about 90 x 60 feet. The walls, which are very lofty, are of three-inch plank laid horizontally and lapped so as to resemble rustic masonry. The interior is divided by two rows of pillars forming the nave and two side aisles, the walls being finished with dressed cedar boards. The work looks remarkably well.

We next visited the carpenters' and blacksmiths' shops, soap factory, storehouse, etc., all of which are managed entirely by Indians; there is also a saw-mill some

distance off which we had not time to visit. All round the bay were well-cultivated gardens and potato patches.

The mission house contains the apartments of Mr. Duncan and his assistants, and has accommodation for a limited number of boarders. There is a large, square common hall with a fireplace in the centre, around which were seated about a dozen Indian girls verging on womanhood. These are taught reading, writing and arithmetic, sewing and other useful employments, which acquirements are highly appreciated by the Indian men, and the educated girls are in great request for wives. These girls sang some hymns and the national anthem very sweetly; they generally have fine voices.

We next visited some of the houses, which were scrupulously clean, the floor being covered with mats of home manufacture, made from reeds and the inner bark of cedar trees.

In the evening, we were invited to a meeting in a large building now used as a schoolhouse. Nearly every soul in the village attended; the men ranged on one side, the women and children on the other; all were neatly dressed in civilized costume, the bright bandanas on the heads of the women and children alone betraying Indian tastes.

Several of the men addressed us in the Tchinsain language, which Mr. Duncan interpreted; they all expressed satisfaction at our visit, and that we should take an interest in their welfare. Their simple ideas were forcibly expressed in figurative language characteristic of their race.

Chief Justice Begbie, who was one of the passengers, then addressed them at considerable length, encouraging them in their endeavours to raise themselves in the social scale. Mr: Seymour and myself added a few kind words. They then all joined in a village song, and concluded with the national anthem. We were all very favourably impressed with what we had seen.

June 10th.—At daybreak we steamed out of the Bay of Metlahkatlah, and at seven a. m., arrived at Port Simpson, a small bay near the entrance of Portland Inlet. Here there is a large Tchinsain village divided in two by a creek through which the tide flows: across this the Indians have constructed a trestle bridge about six hundred feet long and fifteen to twenty feet high. It was here that Mr. Duncan first commenced his labours, and a remnant of his former school is now conducted by native teachers. On the other side of the creek there is a missionary school in connection with the Methodists. We visited both schools, heard speeches and made replies similar to those at Metlahkatlah. At six p. m., we got under way, and before it was dark had passed the dangerous rocks that lay near our course.

June 11th.—At six a. m., we arrived in Masset Harbour, on the north end of Graham Island—the most northern of the Queen Charlotte group—and anchored opposite an Indian village of one of the Hyda tribes who occupy these islands.

This end of the island is low, and much of it is fit for cultivation. In a walk of three miles we passed over some fine land, covered with fir, cedar. hemlock and some birch, with small patches of prairie on which were grazing cattle belonging to the Hudson's Bay Company who have a trading post here.

The Hyda Indians are a manly race, and a few years ago they were formidable, numbering several thousands, but are now reduced to about six hundred on these islands. They are stronger, both mentally and physically, than the other Indians we had met on the coast, their complexion is lighter and they speak an entirely different language. They are good carvers both in wood and metal, and make baskets, hats, mats, etc., from the inner bark of cedar trees, which they ornament with bright colors of their own manufacture, mixing them with fish oil.

Their houses are framed with very large timbers, and are generally from forty to fifty feet square, with walls fifteen to twenty feet high, of cedar plank three to five feet wide and two to three inches thick. The roofs of similar plank and low pitched, with a large opening in the top for the escape of the smoke; over this is a board screen or valve balanced on the roof tree; a string is attached to each side of

this by which that to windward is pulled down flat on the roof and the smoke escapes on the other side freely.

The gable end faces the street, and in the centre of this is placed the family tree or standard, from two to five feet in diameter and thirty to sixty feet or more in height. On this is carved the heraldic legend of the family which often covers the whole standard from bottom to top. The crests are generally a bear, wolf, beaver, eagle, or some nondescript fish. The entrance to the house was formerly by a hole cut through this standard, but now there is generally a door on iron hinges at one side.

The house is entered from a platform from four to six feet high; and inside, on the same level, a platform eight to ten feet wide runs all round the house; their beds, chests and stores are placed on this; and steps lead down to the lower floor in the centre which is planked, except a square fire-place paved with stones. I have seen no houses in civilized life equal to these for rough comfort, and the warmth afforded to a large family at a small cost of fuel.

These Indians are heathens, but Mr. Duncan is thinking of establishing a mission among them; I doubt, however, if he will find them as tractable as the Tchinsains.

June 12th.—We left Masset Harbour at 5 a.m. for Bella Bella, and at 8 a.m., had cleared the sandspit on the north-east coast of Graham Island. The weather was bright and warm and we made a straight course for the Principe Channel, which we reached soon after noon; thence our course lay through the Nepean and Estavan Sounds, the Loreda Channel, Millbank Sound and Seaforth Channel. Steaming all night, we reached Bella Bella at 9 a.m. next day, and within an hour entered the Gunboat Channel, which is very crooked and in places so narrow between rocks and reefs, covered at high tide, that it is not a safe passage for ocean steamers. Soon after noon we entered the Dean Channel, but it rained nearly all day, and the mist hung on the mountains, so that we got only occasional glimpses of their summits which were more or less covered with snow, and increased in altitude as we ascended the channel; their rugged slopes terminating in cliffs or steep shelves coming down to the water's edge. This channel is about two miles wide, with very deep water, and no sheltered bays or safe anchorage except near its head. In the evening we reached a large flat or tongue of land projecting from the east side more than halfway across the channel. This is about six or seven miles from the head of the channel and has been formed with the detritus brought down by the River Kamsquot which issues from a canyon through a screen of rocks, 300 to 400 feet high and half a mile across, connecting the mountains on each side of the valley, and probably at one time it damned up the river and formed a large lake behind it. The flat is about a mile across, twenty feet high near the lower end, and about 100 feet where it joins the rock; it is covered with red fir and hemlock a foot or eighteen inches diameter. There is an Indian village, of the Bella Coola tribe, at the mouth of the river. We anchored on the upper side of this flat which forms a well sheltered bay; the shores however, shelve down rapidly into deep water, making indifferent anchorage; but wharves for steamers could be constructed at moderate cost. Next day a party of us walked over this rocky barrier to the head of the canyon; beyond that, as far as we could see, the rocky slopes of the mountains rise directly from the river. In the afternoon steam was got up, and we ran to the head of the channel but had some difficulty in finding anchorage; for this, like all the other inlets forming the cascade chain terminates with a low flat, shelving abruptly into deep water.

"The River Tshatsquat, which comes in at the head of the channel, is about 400 feet wide at its mouth. About half a mile up it is divided into two branches and several sloughs, covering nearly the whole of the valley, which is half to three-quarters of a mile wide, thickly timbered with red fir, hemlock and cedar. Our guide took a party of us in his canoe about a mile up the river to a small Indian village and fishing station.

June 15th.—We proceeded down the channel; passing the cross channel leading to the Bentinck Arm, and in a few hours reached the head of the North Arm. The

mountains were partly shrouded in mist, but what we could see of them bore a general resemblance to those surrounding Bute Inlet, though the higher ranges behind did not look so broken and were more dome-shaped than peaked. The slopes of those abutting on the arm descend more abruptly to the water than those on the west side of Bute Inlet, and this is the character of all the northern inlets. It would be impracticable to construct a railway on their shores on account of the enormous cost. The arm is about two miles wide and the River Bella Coola, or Woodhalk, which enters at its head, is about 400 feet wide at its mouth ; but a short way up it is divided into several branches and sloughs. A party of us went by canoe about a mile up the river to the Indian Village and Hudson's Bay Company's trading post. In the garden were fine crops of turnips, carrots, potatoes, &c., but the soil appears rather light and sandy. The valley is covered with fir, hemlock, cedar and a good deal of underbrush. I have reason to believe that the description of the pass, through the Cascade Mountains, by Lieutenant Palmer in his report of survey, is in the main correct, and that no farther survey is necessary.

Millbank Sound is the best entrance from the Pacific Ocean to the Gardner and Dean Channels ; for, though it is open to heavy gales from the south-west, the offing is clear of rocks and a very short time will suffice for a vessel to get into sheltered waters. This is not the case with either the Fitzhugh, Loreda, or Nepean Sounds; all of which have dangerous rocks at their entrance, and are scarcely less subject to gales than Millbank Sound. From Millbank Sound, the course to Gardner Channel is by the Finlayson and Ursula Channels, the navigation being good. On our outward trip we passed through these in the night when there was no moonlight. From Millbank Sound to the Dean Channel the most direct course is by Seaforth Channel and the Gunboat Passage; but the latter is crooked and narrow, with many rocks and reefs, barely covered at high tide. The better course is by the Laura Passage farther south ; or, leaving Seaforth Channel on a north-east course, there is a good passage north of that to the Gunboat Channel.

Exploration between Lac la Hache and the valley of the North Thompson, viâ Blue River.
(Route No. 5.)

On my return to Victoria, I received Mr. Hunter's Report of his second exploration of the line between Lac la Hache and the North Thompson, by the valley of the Blue River.

Mr. Hunter took up the line at the point where he and Mr. Jarvis had closed their season's work in 1873 ; and he soon discovered that the stream which they had mistaken for the Clearwater was an affluent of that river, falling into Lake Mahood about four miles from its head ; this he now calls River Deception.

The height at the crossing of this, as indicated by the aneroid, is 3,280 feet above sea level. The distance to the summit of the divide between this and Clearwater is estimated 25 miles, and the height at the summit 4,100 feet.

On the first six miles the rise is 220 feet, or nearly 37 feet per mile; then in 13. miles more it is about 23 feet per mile, and on the last six miles it is 50 feet per mile. Throughout this distance the line follows the valley of the east branch of River Deception, and there would be no heavy work.

From the summit of the divide to the River Clearwater the distance is estimated in 13 miles, and the descent is very rapid, being in the first four miles at the rate of 94½ feet per mile, on the rest of the distance it is 187½ feet per mile. But Mr. Hunter thinks that by following a valley which takes a North-East course from the summit down to Clearwater, the gradients would be greatly improved.

The Clearwater at this point is 2,500 feet above sea level; thence eastward to an arm of Murtle Lake, on the divide between the Clearwater and the North Thompson, the distance is 15 miles, and altitude of the lake 3,700 feet. On the first eight miles the rise is 112½ feet per mile, on the remainder it is about 43 feet per mile.

The line then follows along the south shore of Murtle Lake, on a narrow flat

between it and the mountains, to its east side, a distance of 12 miles. In five miles more, on an easterly course, the summit of the divide was reached, altitude 3,800 feet above sea level.

From the summit, eastward, the descent in the first five miles is 150 feet, or 30 feet per mile in an open valley; but at this point the mountains close in and the stream (a branch of the Blue River) rushes through a canyon five miles in length, falling at the rate of 136 feet per mile. Immediately below this, where the north branch of the Blue River comes in, it opens out into a fine wide valley, which extends to its junction with that of the North Thompson, with a falling gradient of about 30 feet per mile.

Mr. Hunter gives the distance from the Clearwater to the North Thompson as 60 miles; but this is certainly over-estimated, as distances travelled through a rough country generally are, and at least 20 per cent should be deducted.

Though this route is shorter than No. 4, and the works would be lighter, yet the gradients are so unfavorable that I did not think it worth an instrumental survey. I therefore instructed Mr. Hunter to form a Division (Y), and commence a re-survey of that portion of Route No. 4, from William's Lake across the Fraser and on to the Chilcotin Plateau.

Examination of Passes through the Cascade Mountains from the River Fraser to the Similkameen.

I left Victoria on the 26th June, 1874, on a journey through the districts in the southern part of the Province; at Fort Hope I met Messrs. Trutch and Cambie, and received their report of an examination of the Passes through the Cascade Mountains, between the Rivers Fraser and Similkameen.

They commenced at Fort Hope and followed up to the Nicolaume Valley, by the old waggon road, to Summit Lake, 12 miles; rising in that distance 2,024 feet, or 169½ feet per mile. Thence they descended by the Sumallow Valley to the River Skagit 10½ miles, falling about 24 feet per mile. The height of the last point is 1,900 feet above sea level.

They then followed up the main stream of the Skagit seven miles, rising 90 feet per mile; thence up a tributary of that river to the summit of Allison's Pass, 13 miles, rising 144 feet per mile. The summit of the pass is 4,400 feet above sea level. A few hundred feet beyond this, they struck the south branch of the River Similkameen which flows on a south-easterly course. This line was considered impracticable for a railway; the party accordingly returned to the Coquihalla Valley and carefully examined all the principal streams flowing into it on the east side, with the view of finding a way to the head waters of the Tulameen—sometimes called the north branch of the Similkameen—but without success. All the valleys in that direction headed into high mountains, covered with deep snow; this was in the last week of June. The main valley of the Coquihalla was then examined to see if it were practicable to get a uniform gradient throughout from the Summit Lake to the River Fraser, and so avoid the worst gradients in the survey of 1872. It is probable that this can be done, giving a gradient of 100 feet per mile for 35 miles, but it would be at the cost of excessively heavy works, including a great length of tunnelling and massive snow-sheds, as a protection from the avalanches of snow which roll down the steep sides of the valley, bringing with them quantities of timber and loose rocks. But the pass is so rugged that the magnitude of the works in the construction of a railway through it can only be determined by a careful instrumental survey, whichit was not expedient to make at the time. Therefore, I instructed Mr. Trutch to form a Division (V) and make an instrumental survey from Fort Hope to Burrard Inlet, crossing the Fraser at the most favourable place.

Journey from Fort Hope to the Valleys of the Similkameen, Okanagan, and others in the Southern part of the Province.

I had a small pack train sent to me at Fort Hope, and with this I commenced my journey on the 29th of June. Following the waggon road by the Nicolaume and Sumallow Valleys to the River Skagit, I took the Grant Trail up the valley of the latter, the slopes of which are in many places steep and rocky, to the summit of the mountain, which the aneroid indicated to be 5,600 feet above sea level. There were still some patches of snow on the trail as we crossed the brow of the mountain, but as we began to descend the eastern slope, the ground was covered with wild flowers, and thence the descent was easy. After a pleasant ride down the Whipsaw Valley we arrived on the evening of thé 1st July at the Nine Mile Creek; so called from its being that distance from Princeton at the confluence of the two branches of the Similkameen. Here we had entered on the bunch-grass country, and the slopes of the mountains, gently undulating and dotted with clumps of firs, presented the most charming landscape. As far as the eye could reach it looked like one immense deer park.

The valley of the south branch of the Similkameen as it issues from the mountains, is narrow and tortuous, so that even if the Allison Pass had been practicable there would have been a considerable quantity of heavy work in constructing the railway on the east side of the mountains.

Princeton is now simply the ranche or farm of Messrs. Allison & Hays, large stock raisers, but it was once laid out for a town when gold was found on the tributaries of the Similkameen. I proceeded down the Similkameen to near the boundary line; thence eastward by a pass through the hills to Ossoyas Lake in the Okanagan Valley. The Similkameen Valley is narrow and bounded by high hills, principally of trap rock, bare in places; but wherever there is soil it produces a luxuriant growth of bunch-grass. The valley is, in some places, a mere canyon, in others it widens out from a few hundred yards to one or two miles, in which there are flats on both sides of the river fit for agriculture, but most of them would require irrigation. The river is a clear rapid stream varying from 100 to 200 feet wide. Altitude at Princeton, 2,300 feet. About twenty miles below Princeton there is an Indian reservation comprising several hundred acres, fenced in, some of which is cultivated with potatoes and other vegetables; the greater portion of it does not require irrigation.

Around Kereness, some forty miles below Princeton, lately a Hudson's Bay Company's post, there is some fine grazing land; and just below it a low wet flat several miles in length, and one to three miles in breadth, some of which is occupied by white settlers. There is an Indian village or camp at Kereness. Crossing the heights to Ossoyas Lake there is fine bunch-grass. On the margin of the lake near the boundary line, is the farm of Mr. Haynes, who is said to have over a thousand head of horses and about two thousand head of cattle. The valley here is one to three miles wide, including the benches at the foot of the hills, but there is not much agricultural land, as the benches are arid, nor is there water near for irrigating them; there is, however, rich grazing land even to the tops of the hills.

We arrived here on the 4th of July, rode up the trail on the west side of the lake and river about ten miles, to a lateral stream called Tea River, where we camped. The weather was very hot and the mosquitoes ferocious and irrepressible. Altitude 1,500 feet above sea level. Between Okanagan Lake and this point, the river, 100 to 150 feet wide and rather deep, flows through and connects a chain of small lakes, nearly due north and south; but the sides of the valley are very irregular, rocky bluffs sometimes abutting on the water. The trail leaves the main valley and traverses a series of parallel valleys and basins all covered with the richest bunch-grass, till nearing the foot of Okanagan Lake it re-enters the main valley, hugging the steep sides of high sandy bluffs. Towards the end of our day's journey, we reached the foot of the Lake, where, on the west side of the river, there is an extensive low flat covered with willows and alders, which I understand is an Indian reservation, on this there are a

number of neat substantial log houses. Here we crossed the river by a bridge lately erected, and soon after passed the residence of Mr. Ellis, an extensive stock raiser. This is the only white settlement we had seen since leaving the boundary line of Ossoyas Lake. About three miles further on, we camped by a spring half a mile from the lake.

The slopes of the hills abut on Lake Okanagan in many rocky bluffs, and the trail following the eastern shore was reported so rough and miry that we took the trail leading over the mountain, which at the summit is nearly 3,000 feet above the lake, and we found it a hard day's travel of 30 miles to the Mission Valley, where we camped not far from the Roman Catholic Mission; most of the Indians were away hunting or fishing, but Father Grandidier told us those under his charge numbered about 400 souls. This is a very fine valley; the bottom, a low flat of excellent agricultural land, extends four or five miles along the Okanagan Lake, and is partially cultivated by white settlers for several miles up; we saw excellent crops of wheat, oats, potatoes, &c. Altitude of lake by aneroid, 1,120 feet above the sea level. The trail follows up the valley, which takes a north-easterly direction for a few miles; it then takes a course nearly due north and parallel to the Okanagan Lake. A chain of lakes extends through this valley, the largest of which is about 17 miles long. Portions of the bottom lands are fenced in for agriculture, and the slopes produce the most luxuriant bunch-grass. There is a divide in the valley, and the outlet of these lakes is at the north end of the largest of them, where the Coldstream Valley comes in from the east. About four miles up the latter is the ranche of Mr. Charles Vernon, which comprises a large extent of fine agricultural and grazing land, partially timbered, and a considerable portion of it under cultivation. The adjoining hills are covered with the richest bunch-grass.

July 9th.—We were now about seventy miles from the foot of Okanagan Lake, and ten miles from the head of it, which we reached by a fine open valley of rich grazing land, so smooth that waggons and buggies have been driven over the natural surface. Here Mr. F. J. Barnard has a ranche on which a large number of horses are pastured. From the head of Okanagan Lake there is a waggon road to Kamloops, over sixty miles distant, following the Salmon River to Grand Prairie, thence by a narrow valley to the south branch of the River Thompson, and down the left bank of the latter to Kamloops. About twenty miles of this is through timbered lands; the rest being park-like rolling land similar to that about Kamloops. The road, for miles together, is simply a track on the natural surface of the ground, and there is no heavy excavation on any part of it. The most remarkable feature on the road is Grand Prairie; a beautiful low basin among the hills, containing several thousand acres, a great portion of which is fine agricultural land, on which there are several settlers. I was informed that the depth of snow rarely exceeds nine inches, and that 1,700 head of cattle have been pastured there throughout the winter, and have come out fat in the spring. There is a low valley running north-eastwards from the head of Okanagan Lake connecting with Shuswap or Spillemeechene River. Through this valley there is a chain of ponds and swamps so little above the level of the lake and river at either end that a canoe has been taken through from the one to the other. The distance is probably under twenty miles, and a canal could be cut across at a very moderate cost, which would form a link in a line of navigation for small steamers which would be over 300 miles in length, through the most fertile portions of this district, viz.:—

From Savonna's Ferry on the Thompson River at the foot of Lake Kamloops, up the latter and the Thompson River to Kamloops, from which there would be a branch up the North Thompson to Clearwater, 75 miles. From Kamloops up the south branch of the Thompson, on which there are many fine farms, to Lake Shuswap. Traversing the latter to any point desired, we could then pass up the Spillemeechene River and through the canal to Lake Okanagan, thence to any point on the same and down its outlet, as far as navigable, towards Ossoyas Lake. With this, the rich district of Nicola Valley could be connected, at small cost, by a good waggon road to Kamloops, there being already an excellent trail through a fine open bunch-grass

country from the Nicola Valley to the Similkameen; thus traversing and connecting some of the fairest portions of British Columbia; those, too, which comprise the grazing districts *par excellence.*

Exploration from Lake Clearwater to the Valley of the North Thompson.

We arrived at Kamloops on the 11th of July where I received the Report of Mr. Jarvis which had come in two days before by an Indian express from Tête Jaune Cache.

Mr. Jarvis went up the River Clearwater to the lakes, thence north-eastward across the divide to the Cariboo Fork of the North Thompson. The summit of the divide was fully 7,000 feet above sea level, at the lowest place he could find, which was over an immense glacier.

As this was clearly impracticable for the railway line, he took his division on to Tête Jaune Cache, and commenced the survey down the Fraser Valley. As this contingency had been foreseen and provided for, there was no change to be made in the disposition of the other surveying parties.

Re-examination of that part of Route No. 1 between Kamloops and the Coquihalla Pass.

In the progress Report of 1874 (Appendix E, page 148) it is stated that:

"The grade on the first three and a quarter miles, from the crossing of the River Thompson, rises 1 per 100; and on the next three and three quarters miles, 2·40 per 100 or 126·72 feet per mile."

"The average grade on these seven miles is about 92 feet per mile; but if it were possible to get a line giving this, it would be at the expense of still heavier works."

The above is a description of the line surveyed in 1872; but I now made a personal examination, and found that by crossing the river lower down near the forks and curving round the base of the hills on the south side, about a hundred feet in height could be gained before reaching the bluffs, by which the heavy excavations would be much reduced, and possibly a uniform gradient of 77 feet per mile could be obtained on the next seven miles, whence the Valley of Campbell's Creek could be reached with moderate works.

The bottom flat of this valley is only a few hundred feet wide, covered with alders and willows; but the slopes are of easy inclination and passably uniform; they are covered with bunch grass, dotted with clumps of red pine; and only in a few places are there ridges of rock projecting into the stream. Thus, there are facilities for obtaining moderate gradients without very heavy works.

Through the divide between the Valley of Campbell's Creek and that of Stump Lake there is a canyon about half a mile long. The summit altitude is given in my Report of 1874, 2,900 feet above sea level; this is a clerical error; it should be 2,600 feet.

The descent from Stump Lake to Nicola is through a beautiful open country, and I have no doubt that the worst gradients on the line surveyed could be much improved by a slight deviation.

The Nicola Valley, at the head of the lake, is fully a mile wide, the bottom flat, is low and wet, but, with drainage, would be very fertile land; it extends six or seven miles above the head of the lake, and is all taken up and occupied.

The line surveyed in 1872 follows the west bank of Nicola Lake and River to the Coldwater Valley, thence up the same to the Coquihalla Pass.

Later this season I made a journey from the east side of Lake Nicola, up McDonald's Creek and across the divide to Otter Creek and the north branch of the River Similkameen, to see if it were practicable to reach the Coquihalla by that route, which is through a fine open country—but high and rolling. I doubt if a line for the railway could be got this way so good as that surveyed by the Coldwater.

In the Nicola Valley, on both sides of the lake and river, there is a considerable quantity of rich agricultural land, with fine bunch-grass on the slopes of the hills adjoining, interspersed with clumps of yellow pine.

Out of these lands, there are two Indian reservations: one near the head of the lake on the east side, the other a little below the mouth of the Coldwater Valley. All the rest is taken up and occupied by white settlers.

At the mouth of the Coldwater, six miles below the foot of Lake Nicola, there are extensive beds of coal of excellent quality; and a few miles further down, on the divide between the Nicola and Fraser rivers, there is said to be abundance of iron ore.

I reached Nicomeen on the waggon road, on July 22nd, where I left my pack train and travelled by stage and steamboat to Victoria. This journey completes my examination of the central plateau from the boundary line to the Chilcotin country, beyond the 52nd parallel of north latitude.

Exploratory Journey on the Central Plateau, between the Coast Chain of Mountains and the River Fraser, from the Chilicotin Country northwards, to Lake François and the Rivers Nechaco and Stewart.

I left Victoria on the 5th of August to arrange for this exploratory journey. Various business detained me on the way, and I only reached William's Lake on the 14th, where I spent several days examining the line being surveyed across the Fraser to the Chilcotin Plateau.

I put Mr. H. J. Cambie in charge of this Division (Y), and took Mr. Hunter with me.

We arrived at the mouth of Quesnelle on the 29th of August, with my own pack train, and a heavy train with supplies for Divisions M, N and X. Here we found Mr. Seymour, our interpreter, and the Chilcotin chief Aunahime, whom he had engaged as guide and mediator in case any difficulty should arise with the Indians of the district, who formerly bore a bad character.

Our course was northwards by a series of valleys over an undulating country, covered with firs, spruce and aspens, and seldom exceeding in altitude 3,000 feet above sea level. On our left lay a range of hills rising 4,000 to 5,000 feet above sea level, and forming a divide between the streams flowing northwards into the Fraser above Quesnelle and southwestwards into the same river below that point, or into some of the inlets of the Pacific coast. On the fourth day, we reached the River Blackwater, 45 miles from Quesnelle. Our aneroids gave the height of the bridge crossing the Blackwater 2,110 feet above sea level. The valley is here narrow at the bottom, and the slopes, covered with bunch-grass, wild vetches and pea vine, rise by a series of benches to the level of the plateau, which on the southern side is 400 to 500 feet higher, and on the northern 300 to 400 feet, the latter being the lowest part of the divide between the Blackwater and Chilacoh Rivers. At the bridge, the river enters a rocky canyon through which it flows eastward on its course to the Fraser. The Blackwater has its sources in a number of lakes on the central plateau, 60 to 100 miles westward of this point among the foothills of the Cascade Mountains. It is plentifully stocked with fine speckled trout, and the groves of aspen and spruce which adorn the softly undulating grassy slopes of the sunny side of the valley supplied us with abundance of grouse. We afterwards found that this, the 53rd parallel of north latitude, is essentially the northern limit of the bunch-grass. From this northward, the quantity of rain-fall greatly increases, and drainage rather than irrigation is required.

August 31*st*.—We started from the Telegraph trail on the north side of the valley of the Blackwater, and followed the edge of the same nearly due west for eight miles, on to a range of hills running in a north-westerly direction, where the valley makes a bend to the south-west. From an elevated position we had a fine view up this valley for about twelve miles to its junction with that of the Nazco,

on the direct line to Chisiquit Lake and the Homathco Pass. We were now travelling on the same line taken by Sir Alexander Mackenzie in 1793.

September 1st.—Following a course a little south of west, at the thirteenth mile we entered a fine broad and open valley; crossing this obliquely, in three miles more we came to a clear stream, 40 feet wide, flowing towards the south-east into the Blackwater, about three miles distant. The stream makes a bend here and takes a course nearly due west—looking up stream. We followed this on its southern bank for six miles, where we crossed it, as it there takes a north-westly course, and the valley expands into a plain several miles in breadth. The Indian name of this stream is Is-cul-taes-li, (Blackberry River.) In the evening we reached Trout Lake, a fine sheet of water over a mile in length, and half a mile in breadth, abounding in speckled trout. On a grassy slope on its eastern margin we camped, twenty-five miles from the Telegraph line. Next day, about noon, we crossed the spur of a hill 2,980 feet above sea level, and a few miles further on, the trail again struck the left bank of the Blackwater, which had made a bend to the north-west from its junction with the Nazco. The river from where we struck it for four miles up is expanded into a lake. We camped by a small stream, the estimated distance from Telegraph trail, being 42 miles.

September 3rd.—Mr. Hunter and myself made an excursion northwards to the crown of the table-land, 3,508 feet above sea level. The ascent was easy, few rocks appearing on the surface, which was thickly covered by small firs, swept through by fire. The whole country round was rolling and covered with similar useless timber. Retracing our steps, we reached the trail at 1 p.m., and in two hours more came to the foot of a beautiful lake, an expansion of the river, about eight miles long and three quarters wide across its broadest part, and dotted with islands. Its southern shore is high, and, being on the shady side of the hill, is densely covered with dark spruce and cedar trees. But, on the other side, the undulating slopes of the valley, rising 200 to 300 feet above the lake, are covered with bunch-grass, vetches and pea-vine, and groves of aspen, forming a charming landscape. In the evening, we reached the ford where the trail crosses the river, sixty miles from the Telegraph line. Altitude of river, 3,145 feet. Next day, Mr. Hunter and myself, accompanied by our Kluskus Indian, ascended to the summit of a range of hills, crossing the river and bearing in a north-west direction. Our altitude was about 4,500 feet, from which we had a very extended view of the country all around, and could trace the valley of the Blackwater twenty-five miles up, nearly due west. At the foot of the range on which we stood, and north of us, lay a large horse-shoe shaped lake, which the Indians told us flows into the Nechaco. The men were engaged all day rafting the stores and baggage across the river, which was too deep to ford.

September 5th.—We got across the river and, following up a valley three miles, we arrived at Kluskus Lake, where the Hudson's Bay Company formerly had a fort, but not a vestige of it is now to be found. This is still, however, a favourite resort of the Indians. Altitude of the lake by aneroid, 3,500 feet: it is about three miles long and half a mile broad, with muddy bottom; a light breeze makes the water unfit to drink. Three miles further on we camped by a spring, near another small lake, where we remained over Sunday. Meanwhile, we had sent an Indian to find out Mr. Gamsby, and on Sunday afternoon he arrived from his camp, distant about 20 miles westward.

September 7th.—We followed the trail which still kept on in the same course, a little to the south of west, on a bench parallel to the Blackwater. Towards evening, we reached Thratcha Lake and, following its southern shore, we came upon the camp of Division X. The position of this camp was found, from observation of the sun's meridian altitude, and the instrumental surveys of this Division (X) carried from the coast, to be lat. 53° north, long. 124° 53' west, and the height of Lake Thratcha 3,310 feet above sea level. Noting the variation of our instruments, we took this as a new point of departure; and on the 9th September, we continued our journey; our trail keeping the same general course, a little to the south of west, threading a line of small lakes and ponds and cutting off the bends of the Blackwater. In about six miles the trail divided into two branches, that on our left taking a south-west course,

apparently directly across a high range of hills, capped with snow; but the Chilicotin Chief, Annahime, told us that there is a depression in the range by which the trail goes to Lake Nacoontloon, where his principal camp is, thence up the stream southwards to Lake Nimpoh, where it joins the Bella Coola trail from Alexandria to Bentinck Arm. This is the line taken by Sir Alexander Mackenzie in 1793. We took the trail to the right, and at twelve miles crossed the Blackwater, 100 feet wide and less than two feet deep; altitude 3,600 feet. We were now in a wide valley, almost an open plain, through which the river flows only a few feet above the general level. At the fourteenth mile we came to a small lake, altitude 3,740 feet, near which we camped.

September 10th.—Our trail now ran through small burnt timber which impeded our progress; but at noon we came upon a wide, well cut trail, having the appearance of white men's work, but were told it was the work of an Indian who had recently died of fever; in about an hour we came upon his house and grave; a lovely spot on a grassy knoll at the outlet of a lake, four miles long and two miles wide across the widest part, altitude 3,610 feet, and 21 miles from our starting point at Lake Thratcha. This is called Eliguck Lake; the stream issuing out of it, twelve feet wide, is the Blackwater; at this a large black bear was drinking, but, on seeing us, he made off before we could get a shot at him, From this we followed a well cut trail on the north side of the lake, till we struck a small stream running into the west end of it. From this point the trail took a north-west course, and in a mile we came to the foot of a small lake, altitude 3,630 feet. We were now evidently near the water-shed: there were low lumpy hills all around, with rocks appearing on their summits. A mile further on we were on a hill 4,000 feet above sea level. From this we could see through an opening at the head of the lake into a lower basin, extending away to the north-west; the rocks on the shore of the lake, near its head, appeared in the distance like basalt. Continuing on this high ground, on a generally westward course, at the thirtieth mile the trail went over the crown of a large globular rock of granite, altitude 4,050 feet. We were now sure we were on the divide, for on a course south 19° east, we had a magnificent view up a valley between the high range of hills that had been on our left the last two days, and the main ranges of the Cascades. This is the valley of the Salmon River, at the head of which lies Lake Nacoontloon. From this point, keeping the same general course, we began to descend very gradually by a chain of marsh meadows, ponds and lakelets, and at 34 miles we came to an Indian house and grave on a beautiful grassy hill close to, and commanding a fine view of Lake N'ghaco, which is of an irregular shape, 2½ miles long and 1 mile wide; altitude, 3,500 feet. The Indian house is large and well built, but now deserted. Here the trail ended, and our Indians knew nothing of the country beyond and wanted to turn back; but I was anxious to reach the Salmon River before turning northward; and questioning two Indians, who had overtaken and followed us all day, they said we could go to one branch of the Salmon River in a day, but there would be a great deal of chopping. After some coaxing they agreed to go with us.

Sept. 12th.—We followed a generally south-west course, passing the upper end of Lake N'ghaco, thence along the edge of a line of marsh meadows on wet ground, across which we got the animals with great difficulty, keeping nearly the same level to the 41st mile, when a wide and deep valley spread out before us and we began to descend rapidly, till at the 43rd mile we struck a fine clear stream 200 feet wide, altitude 3,180 feet, which we forded without difficulty as the water was now very low and the depth on the ford was little over two feet. This is the main branch of the Salmon River. Our last-come Indians pointed out to us a high range of hills, dim and blue in the distance, which they said lay along the north branch of the Nechaco stating that between us and that river there were many lakes, and we should have to cross two large rivers. They had agreed to go with us at least half the way, but now they told us they were afraid to go, there being so much water and fallen timber they thought our horses could not get through. I insisted on keeping them to their bargain, but next morning we found they had decamped during the night.

Sept. 14th.—We took the bearing to the distant mountains, and started boldly

on our course without any trail, cutting our way through brush and fallen timber. We soon came to the river, which we could not cross, as the water was deep and the bottom miry, so we had to go back to the ford by which we had previously crossed. Our route from the Telegraph trail up the Blackwater Valley and over the divide to this point had appeared so favourable for a railway line that I was sorely tempted to follow this valley down towards the coast as far as horses could go. But the main object of this journey was not to follow out any particular route, but to get a general knowledge of the country as far north as Lake Francois, so as to enable us to determine which line, if any, through the Cascade Mountains north of Bute Inlet, appeared sufficiently favourable to warrant an instrumental survey. I thought this could be done most satisfactorily, and in the shortest time, by tracing the watershed or divide between the Pacific Coast and the River Fraser from Fort George to Quesnelle, and following as near to the divide as practicable so as to cross the head waters of all the rivers flowing east. This has been accomplished, and the results laid down on the general map, but, as the country is entirely unknown, a brief description of our journey may be interesting:—

Our course was north 12° west (astronomical bearing), and we kept as near to this as the difficulties of the ground and the thickly wooded country would permit. At three miles from the river we crossed a divide running nearly east and west, about 120 feet above the river; on the north side of this is a steep rocky ledge of 150 feet, which we scrambled over with some difficulty, then descended gradually into a wide basin intersected with beaver dams, near one of which we camped, eight miles from the river, altitude 3,000 feet. Next day we passed over a similar country till at noon we came upon Lake Qualcho, bearing about east and west, and, as far as we could see it, about four miles long and three-quarters of a mile wide; we followed its shore eastward two miles to the end of it, where we found a stream 8 feet wide, flowing into the lake from the east. This puzzled us, for looking westward down the lake the view was terminated at no very great distance by the snow-clad peaks of the Cascade Mountains. The overflow of the lake must, however, fall into the Salmon River, as its altitude, 2,820 feet, is less than that of the next stream we crossed falling eastward. We now followed a course north 15° west, to carry us over a depression in the range of dark-looking hills ahead of us. A fire had passed over this and we struggled slowly through piles of small burnt firs till we reached the summit, 3,400 feet, beyond which, on the shady side of the hill, the fallen timber became larger, the piles higher and more continuous, and it took us three hours to cut our way a little over a mile to a small pond in a swamp, round which there was a little feed for the animals. Near this we camped, 15 miles from our starting point at the Salmon River, altitude 3,180 feet. This is the real divide between the streams falling east into the Fraser, and west into the Pacific; from this it takes a westerly course till it joins the Cascade Mountains, which then form the divide northward till beyond the 54th parallel of latitude.

Sept. 16th.—It had rained heavily during the night, and this morning we were three hours cutting our way half a mile through heavy burnt and fallen timber to a belt of green standing wood, on reaching which our Indians were so fatigued and disheartened they declared we should all perish if we continued on the same course, as the whole country in that direction had been swept by fire, and it would be impossible to cut through the fallen timber; besides this there was a long lake directly on our course, the head of which they said was two days' travel in the direction of the Snow Mountains. Our experience thus far gave so much probability of the accuracy of this account that we reluctantly changed our course and followed the belt of standing timber in a north-easterly direction. The country became more open and level as we advanced, and the travelling improved. Early in the afternoon, we got a glimpse of the lake to the north of us; then we struck an Indian trail which led us to the foot of it, where we camped on a grassy bench, commanding a fine view up the lake with the snowy peaks of the Cascades in the distance. General bearing south 63° west, estimated length of the lake, as far as we could see it, fifteen miles, but we could trace the course of the valley a long distance

beyond that. This is Lake Tschick, altitude by aneroid, 3,100 feet, and distance from our starting point on Salmon River, 34 miles. The stream flowing out of it in a north-easterly direction is not over twelve feet wide.

This part of the country is said to have been once thickly populated with Indians, which is probable, as it abounds in game and fish ; there is now little trace left of them but their graves. The bottom flat of the valley, from the foot of the lake, widens out to fully half a mile, covered with good grass, but two or three miles down it becomes marshy, probably the result of beaver dams. To avoid a high hill that lay directly in our course, we followed down the edge of the valley on the north side four miles, where we found an Indian trail, leading round the flank of the hill. This we followed and made good progress till we got on the north side of the hill, where our difficulties with fallen timber increased, and the country became sterile and dreary. After a hard day's struggle we reached the head of the south arm of Lake Tetachuck an hour after it was dark. This is a trefoil or T shaped lake, surrounded by high sterile hills of shaly limestone, rising to a height of nearly 4,000 feet above sea level. It took us the whole of next day clambering round on the steep slopes of these hills to cross the angle between this arm and the outlet of the lake, a distance of eight miles.

From these heights, we took a general bearing up the lake and valley, south 72° west, extending up to the Cascade Mountains. At sunset we reached the foot of the lake, 48 miles from our starting point, and camped. Altitude of lake, 2,770 feet. The outlet of this lake is a deep and rapid river 200 feet wide, which we were unable to ford, so we had to make a raft to carry our stores and baggage across the foot of the lake, and the animals had to swim nearly a quarter of a mile. This wasted half a day, but on the sunny slopes of the hill, on the other side of the river, we found plenty of grass, pea vine and service berries in the aspen groves ; and as the animals had had but little feed for the last two days we were glad to give them half a day to recruit on good pasture, as well as to rest ourselves, and so camped on a sunny glade near the margin of the lake. From this, it took us another hard day's travelling to get across the next divide, nearly a thousand feet above the level of the lake, with much fallen timber on the north side to the valley of the Euchu, which we struck at the head of the lake on a grassy flat a mile wide. The river flows on the north side of this, and was then only 60 feet wide where we forded it; but the channel is 150 feet wide, and the driftwood on its banks showed that it is subject to high floods. Here we camped, distance 61 miles, altitude 2,700 feet. About 3 miles above where we crossed, the valley contracts, and is there divided into two branches which rapidly head up to the level of the plateau. The slopes or benches on the sides of the valley, broken by lateral gulches, appear like a chain of rounded hills, rising to a height of 300 or 400 feet ; those on the north side of the valley, more exposed to the sun's rays, are covered with grass, vetches and pea vines. From one of these hills we took a bearing eastward to a remarkable peak in the high range of hills that we had seen on our right the last three days. It is a high dome with a peak rising up in the centre, not unlike a spiked helmet. We called it Fanny's Mountain, after our Kluskus Indian, to whom it was a landmark showing where the river Nechaco cuts through the range in a deep canyon impassable for canoes.

Sept. 21st.—The country had been improving on our route the last two days, and the first part of this day's journey was the pleasantest we had since leaving the Salmon River. We followed up the north side of the Euchu Valley, two miles, thence northward by a small stream flowing into it through a lateral valley. The woods on the slopes of the hills on each side opened out at intervals into grassy glades. This continued till we got on the north side of the hill, when we had our usual difficulties with fallen timber, but at last we reached the long-looked-for Nechaco, which we struck at the foot of Tchutazely Lake, an expansion of the river one to three miles in breadth. The river, at this place, is fully 300 feet wide and too deep to ford, so we camped, distance from Salmon River 74 miles; altitude, 2,680 feet. The Nechaco, from this point eastwards, expands at intervals, forming a series of long narrow lakes, and it receives all the streams we had crossed before it cuts through the range above

mentioned. Like all the country we had crossed, the south side of the valley, being the shady side of the hill, is bleak and cold, with much fallen timber undecayed : but on the bottom flats that occur at intervals between the river and the slopes there is large timber with grass and pea vine. On the north side of the river, where we crossed it, the banks rise from the water's edge very steeply to a height of 200 feet, but by the process of denudation these are serrated and rounded into a series of hummocky hills; and being more exposed to the sun's rays, vegetation is more active and the fallen timber more decayed, so that groves of aspen have sprung up, with luxuriant grass, vetches and pea vine. From these heights, we got another bearing to Fanny's Mountain. It took half of next day to get our stores and baggage rafted across, and the mules packed. We were now puzzled about what direction to take, for across our course lay a high range of trap and basalt, being the same we had seen at starting from Salmon River. While in this dilemma we were surprised to hear the bark of a dog, and, immediately after, a canoe shot round a point of land; this contained an Indian family, man, wife and three children, with all their goods and chattels packed in that long narrow dug-out. We could understand but little of each others' speech, but they proved to be remarkably intelligent, especially the woman, who in a very few minutes understood the map and our rough sketches and traced the way to Fraser Lake, where their village is ; we gave them some food and small presents for the children, and the man agreed to go with us two days and show us the Indian trail. We started on a north-west course on the slopes of the hills along the margin of the lake which were covered with very long grass, vetches and pea vine, and groves of aspens. The vetches and pea vine were in great quantity, reaching to a height of 4 feet among the long grass, climbing up the trees to 8 or 9 feet and hanging in festoons from bush to bush ; we had difficulty in forcing our horses through the tangled mass. From a high point we took a bearing up the Nechaco Valley, north 53° west. The river appeared to flow out of a very large lake 30 to 40 miles distant, among the foothills of the Cascades, and beyond this in the same line rose a snowy peak regularly shaped like an Egyptian pyramid, estimated to be over 8,000 feet high and 50 to 60 miles distant. In about three miles, our course changed to north, and we passed through a gap in the range at an altitude of 3,500 feet above sea level. Our course was then nearly north-east, and rapidly descending we soon reached the little Lake Enz, altitude 3,050 feet, distance 78 miles from Salmon River.

Sept. 23rd.—We started early, and in three miles reached the house of an Indian chief, at the head of Lake Tchestata. The range of hills north of us, though high and studded with masses of granite, did not look inaccessible ; the country appeared passably open, and by Trutch's map the distance to Lake François should not exceed 20 miles; but our Indian declared it was impossible for horses to go there, as there was so much rock and fallen timber and no feed, and even if we did succeed in reaching the lake we could not possibly get along its shores to the outlet. We therefore, reluctantly, followed the trail along the north shore of Lake Tchesatta all day till we came to an Indian fishing station ; this lake is one to two and a half miles wide ; altitude 2,800 feet. Here the trail ended, and our Nechaco Indian turned back, first telling us that it was but a little way to an Indian village, whence we could find a trail leading to the foot of Lake François. But we toiled hard, cutting our way through thick brush and fallen timber on the steep hill side, and it was not until 4 p.m. we came to the Indian village on a spit of land shooting into the lake and nearly cutting it in two. We then started on the trail, which, however, did not lead northward, but followed the margin of the lake on high bluffs ; it was nearly dark when we reached the foot of the lake ; distance, 105 miles ; altitude of the lake by aneroid, 2,800 feet.

Sept. 25th.—The Indian from the last village offered to accompany us one day's journey. Our course all day was nearly north-east, on a passable Indian trail ; the first part of the day through a hilly country covered with small timber. From one of these hills we got another bearing to Fanny's Mountain south 30° west, which we were now leaving behind. We travelled by a chain of marsh meadows and ponds or beaver dams, passing several Indian camping grounds, and had a good deal of bridging

and brushing to get the animals across soft ground. Towards evening, we crossed some heights of trap rock, from which we had a view of Lake Kthluthsly lying before us, about 3 miles long and 1¾ miles across its widest part. We travelled on the north shore of this, and camped on a flat near the lower end of it; distance from Salmon River, 118 miles; estimated altitude of lake, 2,900 feet.

Sept. 26th.—From the course we had travelled the last three days I felt certain that we must be fully as far east as the foot of Lake François; so we left the trail and made a desperate attempt to cut our way direct north; but after two hours' labour we had not made half a mile, and had to give it up and return to the trail, which was hard to find among piles of fallen timber and loose rock. We were now crossing a range of bold granite hills, apparently a continuation of the same range we had seen on our right for more than a week past. About 3 p.m. we crossed the summit by a depression in the range; estimated altitude, 3,600 feet above sea level, and had a very extended view over a rolling country to the south-east, in which we caught a glimpse of the Nechaco River and several lakes. Wending our way slowly down the north-eastern slope, over very rough ground strewed with fallen timber, we reached a small lake, altitude 2,900 feet, near which we camped.

Next day we started early, toiling slowly through a hilly and thickly timbered country. In two miles we passed a small lake, out of which issued a stream flowing northward, which told us we were not far from Lake François or Lake Fraser; and shortly after, passing through a defile, we came to a point on a hill-side, commanding a magnificent view to the north-west, overlooking the valley of Lake Fraser and the Stilacoh River, the head of the lake appearing six or seven miles from us. From this I sent a messenger on to Fort Fraser for a canoe and crew to meet us at the head of Lake Fraser, for which we now took a direct course, and in two miles we struck the telegraph trail, 135 miles from our starting point on the Salmon River. We were glad to find ourselves once more on a good trail, and started westward at a brisk trot, halting at each angle to take bearings. The animals regaled themselves on the rich pea vine on the roadside or grass in the open glades. In three hours we reached the crossing of the Stilacoh River at the head of Lake Fraser, and camped by an Indian village. Altitude of lake by barometer, 2,225 feet.

From observations made on this journey we glean the following:—

That the central plateau at the eastern base of the Cascade Mountains from the Salmon River to Lake François is undulating; the crests of the hills or ranges between the streams rising to about 4,000 feet above sea level; and that the streams from the foot of the Cascade Mountains take a general course, varying from east to north-east, all converging on the Nechaco River, which then cuts through a range of hills running generally parallel to the Cascade chain. This range is very irregular and broken, but the line can be traced from the Doglip Hills, on the River Quesnelle, crossing the Fraser below the mouth of that river, thence on a generally north-west course, crossing the Blackwater below Lake Kluskus; thence to Lake François and up its south margin to the Cascade Mountains. The range forms a dam which checks the fall of the streams from the Cascades, and they expand into the numerous lakes we have passed over in our journey. The timber throughout is spruce, black fir, and cedar, generally small and of little value. There is only a little agricultural land in the bottom flats of the valleys, with good grazing land—grass, vetches, and pea vine on the slopes facing the south. We saw no stratified rock except the shaly limestone on the margin of Lake Tetatchuck.

Sept. 27th.—Mr. Hunter and myself started in the canoes up the River Stilacoh. Half a mile up from the telegraph line a stream 40 feet wide comes in from the north—this is the Nettacoh; on the opposite side of the Stelacoh there is an Indian village. Above this, the Stilacoh is a rapid stream 60 or 100 feet wide, where we found the Indians spearing salmon—600 miles from the sea—but the fish were of a pink colour, and inferior in flavour to those nearer the coast. It took us three hours' hard pulling to make the three and a half miles to the falls, where we camped for the night. Next morning we made a short portage with our baggage, and hauled the canoes up the rapid, on which there is a perpendicular fall of four or five feet. We had rapids nearly all the

way to the foot of Lake François, seven miles from the Telegraph trail. Altitude, 2375 ft. We employed the rest of the day catching fine speckled trout on the rapids, while the Indians trolled the lake for whitefish.

Sept. 30th.---Leaving Mr. Hunter to make a survey of Lake François, I went back and reached the Indian village at noon. Our course then lay down Lake Fraser, of which I made a rough survey from the canoe, landing at several points to get better bearings; we reached Fort Fraser before it was dark. Lake Fraser, near its lower end, is bounded by high hills of trap and basalt on each side, the slopes of which at some points come to the water's edge; at others there are intervals of flat land beween the lake and the hills. The Hudson's Bay Company's Fort is at the south-east angle of the lake, and two miles from this, at the outlet of the lake, there is an Indian village.

Oct. 1st. We started, and in a quarter of an hour were in the river Nechaco, not over a quarter of a mile from Lake Fraser. The Nechaco is here a deep and rapid stream 300 to 400 feet wide. In half an hour we came to bad rapids, where we had to make a short portage; after this we went swiftly down the stream, passing over a great many rapids, but none of them very dangerous. I took bearings, and estimated distances by time. General course a little south of east. The valley is generally narrow, with high banks, sometimes of rock; at intervals it widens out a little and there are low flats between the river and the high banks. Next day, we were mostly in still water and the valley widened out more. At noon we reached the Stewart Lake trail where we found our two pack trains camped.

There is not much to be seen from a canoe on a river with high banks, but so far as I observed, there was very little land fit for cultivation; and certainly the banks of the river are not very favourable for a line of railway; but they get lower near the Stewart's Lake trail, and there is a flat country extending away to the south-east. On our way down the river we saw numerous and large flocks of geese and ducks; they were, however, very wary and difficult to get near.

Oct. 3rd.---Directing the packers to find their way down with the trains, by an Indian trail to the mouth of the Chilacoh River, I started down the Nechaco; we were on still water and the valley soon opened out from half a mile to a mile in breadth, with low flats through which the river meanders. As we neared the Stewart River, the valley again contracted and there were high hills on each side of us; the river striking the base of these had caused heavy land slides where the material is clay or loam. In some places there are rocky canyons. We camped at the confluence of the Nechaco and Stewart Rivers. These two rivers appeared to be of about equal volume.

Oct. 4th.—We started down the Stewart River; the stream flowing slowly and varying from 250 to 1,000 feet in breadth. In about 10 or 12 miles we appeared to be passing through a range of high hills; the highest points estimated fully 1,000 feet above the level of the river. The valley is here contracted, and soon we entered a rocky canyon, through which the rapids were very strong for a mile and a half, and the slopes of the hills very rough. At about 14 miles there is a dangerous rapid, where we had to make a short portage. From this the rapids and swift current continue---with the exception of about three miles of comparatively still water---to the mouth of the Chilacoh River; near which are the worst rapids on the river, where a belt of basalt crosses it, and we had to make a portage of half a mile. The bottom flat of the valley is from half a mile to a mile wide, and varies from 20 to 50 feet to above the level of the river; and is covered with small timber---spruce, scrub pine, and aspen. There are some low flats very little above flood level. The Chilacoh, or Mud River as it is popularly called, enters the Stewart River from the south about 20 miles above the confluence of the latter with the Fraser near Fort George. The banks of this portion of Stewart River are generally high, varying from 20 to 80 feet to the bottom flat of the valley, the slopes from each side of which rise in a succession of benches 100 to 300 feet above the level of the river; and there are some very large land slips where the stream strikes the foot of these benches. On the right there is a high range of hills stretching away to the south, parallel with the Fraser;

and on the north an elevated plain extends to the Giscome Portage, or divide between the Fraser and Parsnip Rivers; this is densely covered with timber. The River Stewart widens out at its confluence with the Fraser, and the channel is divided by several small islets so that we were not a little puzzled to know when we had entered the Fraser. Fort George is on the west bank of the Fraser, about a mile below the mouth of the Stewart River, on an extensive flat of apparently good land. There is, as usual, an Indian village near the fort. We arrived there on the 5th October.

I had made an appointment four months before to meet the Divisions M and N thereabout the 1st of October, estimating that they would have finished their work on the Upper Fraser by that time. Division M arrived one day before me and N one day after me. I remained three days at Fort George, during which I got Division M started on the survey from that point up the south bank of the Stewart River to the mouth of the River Chilacoh; and Division N commenced to cut a trail across the high hills to the same point.

I left Fort George on the 8th of October, overtook and camped with Division N; and next day we completed the trail and arrived at the mouth of the Chilacoh, where we met the pack trains, which had just arrived from the Nechacoh. The same day I made a reconnoissance of the country lying in the angle between the Rivers Stewart and Nechaco, and next day I started Division N on the survey up the valley of the latter.

October 12th.—I went on with my party and the supply train up the valley of the Chilacoh, cutting a trail and making a track survey as we proceeded. There is a great deal of scrub fir and other larger timber in the valley, much of it burnt and fallow; so it took us seven days to reach the bend, a few miles east of the telegraph trail, where we left the valley, a distance of about 40 miles. Two miles beyond this we reached the camp of Division X, where we also camped.

The lower half of the Chilacoh Valley is from a quarter to half a mile wide, on the bottom flat, which is a deep loam covered with groves of spruce, pine and aspen, with open glades of very rich grass, red top and blue joint over four feet high, with vetches and pea vine on the slopes of the hills having a southern aspect. The valley is bounded by high benches and a rolling plateau on the west, and on the east by the high range of hills lying between it and the Fraser. About twenty miles up, a range of hills crosses the valley where the latter is contracted to a canyon for a quarter of a mile, but there will be no difficulty in getting a line of railway through this. One of the highest hills in this range is double headed and lies close to the valley. It is the same that we had seen from the Telegraph line two months before and served as a landmark.

Above the canyon, the valley expands at places to fully two miles in breadth, and some wide lateral valleys come in from the north-west. The lower part of this, by the river, from a quarter to half a mile wide, is covered with long grass; then there is a step up from 50 to 100 feet, and the upper flats to the slopes of the bounding hills, are covered with spruce, small pines and aspens. In some places the ground is swampy and would require draining for cultivation. The valley ranges from 2,000 to 2,300 feet above the level of the sea; soil, a light loam, very deep and free from stones. The river is a sluggish stream, 100 feet wide, with deep water, muddy bottom and few fords; it is as crooked as a cork-screw, meandering from side to side of the valley. We found some pieces of lignite on the banks that had been brought down by the current, and there are probably beds of coal further up the valley.

The weather up to this time (15th October) had been as mild and genial as the Indian summer in Ontario, but now the nights were getting cold, with white frosts in the mornings, indicating the speedy approach of winter. I, therefore, gave instructions to the Division Engineers to close the season's operations on the 24th October, and after that to make all haste possible to reach the crossing of the Fraser at the mouth of Quesnelle by the end of the month—whence they would have a waggon road on which they could purchase hay and grain if necessary for the animals—and so on to winter quarters near Kamloops, 200 miles farther south. I went on ahead with my own and with the supply train, and we reached the mouth of

Quesnelle on the 23rd of October. Here I found Division M encamped. They had completed the survey up the Stewart River Valley to the mouth of the Chilacoh, and come down the Fraser---bringing all their stores and luggage in the boats which they had constructed at Tête Jaune Cache, and used on the Fraser River all the season.

I arranged that Mr. Jarvis, with a small party, should make a winter journey across the Rocky Mountains, by the Smoky River Pass, thence to Edmonton and Fort Garry; the rest of the Division going by stage and steamboat to Victoria, where they arrived on the 31st of October. Divisions N and X travelled with their pack-trains to Clinton, thence by stage to Yale, where they met Division Y, which had been surveying the lower canyons of the Fraser, and they all arrived together in Victoria on the 18th of November.

I was detained on the mainland settling accounts, and by various business, and did not leave Kamloops till the last of the pack trains had arrived, and the horses and mules placed on their winter pasturage.

I then went homewards by the Nicola valley, in which I was overtaken by a heavy snow storm, on the 23rd November; and on reaching Lytton, by the waggon road, on the evening of the 24th, I found the snow there over two feet deep. It took us five days to travel thence to Yale, a distance of 57 miles, walking, sleighing, canoeing, and on horseback, at different stages of the journey, the snow being, on the average, fully three feet deep, with heavy drifts at intervals.

The deep road cuttings on the lower canyons of the Fraser were filled up with snow, and together with the steep rocky ribs of the mountains, were covered with glare ice, in which we had to cut footsteps, and thus laboriously thread our way. A slip or a false step would have been certain destruction, insuring a headlong fall over the almost perpendicular cliffs into the boiling torrent beneath.

I arrived at New Westminster on the 1st of December, where I met Mr. John Trutch, whose Division (V) completed the survey to the head of Burrard Inlet on the 2nd of December. Next day we all arrived at Victoria in company.

Instrumental Survey from Fort Hope to Burrard Inlet.

This line was intended to be common to Routes Nos. 1 and 2, which diverge at Kamloops, and re-join each other in the valley of the lower Fraser at Fort Hope.

But a careful examination of the right, or north bank of the Fraser, showed that from Yale downwards, to nearly forty miles below Hope, the banks of the river are very unfavourable for a line of railway, and there would be a very large quantity of rock excavation, some tunnelling and heavy bridging.

The line was, therefore, surveyed from Fort Hope down the left or south bank of the Fraser, 47 miles, where it crossed the River, near St. Mary's Mission; it was then carried down the north bank to Maple Ridge, 65th mile; thence in almost a direct line to Port Moody, at the head of Burrard Inlet, crossing the River Pitt at the 70th mile, and reaching Port Moody at 75 miles from Hope, where the survey was stopped on account of the lateness of the season and bad weather.

The left bank of the Fraser at Fort Hope is about 130 feet above sea level, but the survey was commenced at a point on the slope of the mountain 271 feet above the sea, so as to conform with the gradient of the line coming down the Coquihalla Valley. From this, the line is on broken and rocky side hills and gravel benches, with a falling gradient of 1·50 per hundred for a little over a mile to the valley of the Quickholum River, an impetuous mountain stream 150 feet wide, with a fall of 25 feet to the mile.

Thence to the end of the fourth mile, the line runs on a flat, but in the next three miles the river washes the foot of a precipitous mountain slope, along which the line runs over slides of loose rock and high, narrow benches, crossing the River Oquisahlus, 100 feet wide, between the sixth and seventh mile. On this section of seven miles the works would be for three miles heavy; the balance being light or medium.

The line then traverses a flat six miles in length, crossing the River Shalo, 100 feet wide, near the tenth mile. The work on this section would be light.

From the 13th to the 17th mile, the bank of the river presents a very irregular line, and the rugged and broken slopes of the Tenas mountain come down almost perpendicularly at the water's edge. The line had, therefore, to be carried through a pass at the back of the mountain, with gradients of 1 per 100, rising on one side and falling on the other. On this section, there would be very heavy rock cutting and a tunnel 900 feet long.

From the 17th to the 24th mile the line runs over undulating ground, crossing at intervals the rocky spurs of the mountain, and passing behind the Indian village of Cheam between the 22nd and 23rd mile. The works on this length would be medium.

From this to the river Sumas near the 39th mile, the line crosses a low flat, subject in part to overflow from the Fraser. It crosses the Chiliwhack river, 326 feet wide, near the 33rd mile, and between that and the 36th mile it passes behind the Chiliwhack mountain, a detached mass of rock, one face of which is washed by the Fraser. The River Sumas is 300 feet wide. This section may be divided thus:—For 5 miles on which the line is above flood level the works will be light; on 5 miles where it is a little below flood level, they will be medium, and on the balance, which is subject to overflow three to ten feet, the works will be heavy.

From the 39th mile the line surveyed runs for about two miles on a narrow strip of land between the base of the Sumas mountain and the river Fraser, on which it is not practicable to construct a railway; the line would, therefore, have to be thrown farther into the slope of the mountain, involving heavy rock cutting and a tunnel about 1000 feet in length, rip-rap and other protection works being required at several points.

The next two miles is on a low flat subject to overflow two to six feet in depth; and intersected with several streams. At the 43rd mile the Fraser again strikes the foot of the mountain and the line is on the rocky slopes for a mile and a half, in which there would be very heavy rock excavations and a tunnel 1,500 feet in length.

The balance to the crossing of the Fraser, between the 47th and 48th mile, is on low ground subject to an overflow of one to three feet.

The crossing is at a narrow part of the river Fraser where the banks are low; the breadth of waterway is 1,400 feet, depth at high water 57 feet, bottom gravel and sand. To get proper curvature on the north side of the river 1,600 feet of bridging would probably be required.

From the crossing of the Fraser, the line was carried for six miles on high benches, some distance from the river, to avoid the low ground subject to overflow; these benches are so broken with deep gulches that the works would be very heavy, a line has therefore been projected, as shown on the plan, following the low ground by the side of the Fraser to the crossing of the river Stave, a distance of seven miles. This flat is subject to but a slight overflow, and rip-rap or other protection works would be required, but the works would not be heavy.

The river Stave is 900 feet wide, and its extreme depth, where the line crosses it, is 31 feet, with a hard bottom of clay and coarse gravel. It drains a large lake, some twelve miles distant, and does not flood heavily or bring down much drift-wood.

From the river Stave the line follows the north bank of the Fraser very closely for eleven miles, in which the gradients are undulating; on eight miles the work would be light, and on two miles it would be medium.

The line leaves the Fraser at the 65th mile, and in two miles reaches the Pitt meadows, which are about four to five miles wide and subject to an overflow of two to five feet in depth. They are intersected by a number of sloughs, and the River Pitt crosses near the 70th mile. This river, at the narrowest place where the line crosses it, is 1,240 feet wide; extreme depth, 60 feet; bottom, clay and sand. It drains a large lake of the same name and its current is two knots an hour. The rise of the tide is five feet.

From the edge of the Pitt meadows, at the 71st mile, the ground continues low and wet for a mile and a half—covered with cedar, spruce, fir and alder, and is crossed

by the River Coquitlum, which is here divided into seven branches or sloughs; these could probably be all brought under one bridge.

Thence to the end of the survey, within a mile of Port Moody, the line runs over a high gravel ridge, and the work would be medium.

No survey has been made on the shore of Burrard Inlet to English Bay, but the work would probably be medium, and the total distance from Fort Hope about 93 miles. The works on this Division of the line will average heavy, owing to the great quantity of bridging, together with the rock cuttings and tunnels.

Trial Location Survey from Yale 14 Miles up the Valley of the Fraser.

The average fall of the river on these 14 miles is seven feet per mile; but for the railway line, with curves of 5°, or 1,143 feet radius, gradients of 1 per 100, or 53 feet per mile, rising and falling alternately, had to be used for half the distance to keep the heavy rock excavations within practicable limits.

From Yale the works for the first two miles would be extremely heavy, requiring two tunnels; one, 3,860 feet, and the other, 800 feet long. For the next five miles the cuttings would not be so heavy, but they would be nearly all in rock.

From the seventh mile to the Alexandra Suspension Bridge, a distance of five miles, the mountain slopes recede a little, leaving gravel benches between them and the river; on these there would not be much rock, but rather heavy gravel cuttings. In this section the line crosses the Spuzzim River, which would require a bridge of three spans of 100 feet each.

From the Suspension Bridge, the survey was continued two miles farther up on the right bank of the river, in which distance the rock cutting would be heavy, and a tunnel 1,625 feet in length would be required.

This survey embraces what is called the Little Canyon of the Fraser, and from it we have obtained quantities by which the approximate average cost per mile of the heaviest sections of the line may be ascertained.

Trial Location Survey of that part of Route No. 4 from Lake Williams across the River Fraser to the Chilcotin Plateau.

This survey commences near the foot of Lake Williams, at a point on the line surveyed in 1872 and immediately crosses the José River; it then follows the benches on the south side of the same, instead of the bottom flat of the valley as the former line did.

These benches are very irregular in height, and, at intervals, are broken away altogether by heavy land slips, leaving loose clay and gravel slopes; in some cases a portion of the bench is left standing with a perpendicular face.

In order to get above these on to safe ground, we had to commence at once with a rising gradient of 60 feet per mile for three miles; this gradient, however, can be reduced by bringing the line down the south side of Lake Williams, and commencing to rise further back.

In the next three miles, there is a descent of 90 feet, with varying gradients, and the line crosses the point of a rocky spur in which there would be some heavy cutting and possibly a short tunnel.

The line then commences to turn southward as it enters the valley of the Fraser, and it gradually approaches the river, which it reaches at the end of three miles, in which the descent is 290 feet. The works from Lake Williams to this point nine miles, would be rather heavy, and the steep gradient of the last three miles can only be reduced by increasing considerably the quantity of excavation.

The line crosses the Fraser where it is 1,100 feet wide between two rocky cliffs rising to a height of 390 feet above the river; this would have to be bridged with one span.

This enables us to avoid a great deal of heavy rock cutting and tunnelling on the west side of the Fraser, encountered on the line of 1872, the tunnelling being reduced from 3,500 to 800 feet in length.

The line then bears in a southerly direction down the valley of the Fraser twelve miles, but gradually leaving the river and rising on the slope of the valley with a gradient of 75 feet per mile, to the lateral valley of Sheep creek, up which it turns westward, rising at the same rate for seven miles to the Chilicotin plateau, about 3,200 feet above sea level.

On the first 13 miles from the crossing of the Fraser the works would be heavy, chiefly rock cuttings, with 800 feet of tunnelling as above stated. On the rest of the distance the works would be light.

The survey was carried two miles beyond the last point, and can be connected with that of 1872, by easy gradients and light works; it shortens the Route No. 4, six miles.

Re-survey of part of Route No. 4 between Canim Lake and the Valley of the Clearwater.

This survey was commenced at the foot of Canim Lake, and continued on a high level, so as to get on the top of the bluff, near the foot of Lake Mahoud and avoid the tunnelling, estimated one mile in length, on the line of 1872; but this led over so many deep gulches on the mountain side that it had to be abandoned. It was, however, ascertained that a line could be had from the plateau at the head of Lake Mahoud with easy gradients and moderate work to the *foot* of the bluff near the lower end of the lake.

A survey was accordingly made around the foot of the bluff, a mile and three quarters in length, and a few feet above the level of the lake; and, by using in two places curves of 955 feet radius, it was found that the tunnelling can be reduced to four short lengths aggregating 2500 feet.

The survey was then continued from the foot of the lake down the valley of its outlet to the junction of the latter with the Clearwater, 3½ miles, by which it is shown that the heavy rock cuttings can be considerably reduced; the tunnel, however, 1800 feet in length, remains the same, but the deep ravine on the former line can be altogether avoided.

The survey was not carried any farther, as enough was done to show that by careful location surveys, the very heavy works on this part of the line by the former survey can be greatly reduced.

Route No. 6 Yellowhead pass to Bute Inlet.

This line branches off from Route No. 1, on the southern slope of the valley of the Upper Fraser, 40 miles west of the summit of Yellowhead Pass, and continues in the valley of the Fraser, gradually descending the slope till it reaches the bank of the river a little below Tête Jaune Cache.

Thence, the valley takes a course nearly north-west, in almost a straight line of 140 miles to the Grand Rapids; in which it varies in breadth from one to two or three miles, and is densely covered with spruce, balsam, cottonwood and cedar of large size. The bottom of the valley is composed of an alluvial deposit of sand, gravel and silt, with blue clay in some places, through which the river has cut its way in an exceedingly tortuous line, striking the foot of the slopes on either side alternately.

The mountains on each side of the valley are very high, many of them capped with permanent snow; but after passing the River Shushwap, 83 miles from Yellowheadpass, they decrease in height and recede further from the river.

From the head of the Grand Rapids, the line takes a general course nearly west, passing the north end of the Cariboo range of mountains, and in 60 miles it again strikes the Fraser River and crosses it near Fort George; thus cutting off the great bend of the river and saving 40 to 50 miles in distance.

From Fort George the line follows up the right or south bank of the River Stewart 15¼ miles to the mouth of the River Chilacoh; thence up the valley of the latter 40 miles to the bend of the valley, whence the line continues in a south-

westerly course 20 miles across the telegraph trail to the Black Water Valley; which it follows up 15 miles to the mouth of the River Nazco; thence up the valley of the latter south-westward and across the divide into the Chilicotin Valley, which it follows down 20 miles nearly south. It then leaves that valley, taking a south-west course, by Puntzee Lake and the Chilancoh Valley, to the foot of Lake Tatla, 436 miles from the summit of Yellowhead Pass. Here it joins Route No. 4, and the rest of the distance through the Homathco Pass to Bute Inlet is common to both routes.

In describing the engineering character of this line, the mileage is commenced at the summit of the Yellowhead Pass, so that it embraces 40 miles of the Route No. 1, described in the Progress Report of 1874, which, this survey being only preliminary, it is not necessary to report on here, as it will be referred to in a subsequent report when the surveys are completed.

From the 40th to the 48th mile, the line runs on precipitous rocky slopes with a falling gradient of 1 per 100 for 5¾ miles, and 1·50 per 100 for a mile and three quarters, but these gradients could be much improved by commencing the descent of the valley farther back towards Moose Lake. The works, however, would still be heavy, as the cuttings, though of no great depth, are mostly in rock; but the length of tunnelling can be much reduced, if not avoided altogether.

After this, the line follows generally the sinuosities of the river a few feet above flood level of the river, which falls at the rate of three feet per mile to the Atnah or Shushwap River, near the 83rd mile. On this section the works would be moderate, with the exception of two rocky spurs, requiring tunnels of 600 feet and 300 feet respectively. The principal bridging would be one span of 50 feet at 48½ miles, one of 40 feet at 53 miles, and two spans of 100 feet, each crossing the Shushwap River.

The last point is 2,295 feet above sea level, and the next section extends to Rapide Plat at 126 miles, the line following the bank of the river as before. Rapide Plat is 2,113 feet above sea level; the fall of the river in a distance of 43 miles being 182 feet, or a little over four feet per mile.

The earthworks on this section would be moderate, except on two clay slides, the united lengths of which are 1,300 feet, which would require some protection works at their foot. There are only two important streams to be bridged—Castle River, at the 86th mile, 100 feet wide, and at the 121st mile, a river 100 feet wide.

From Rapide Plat, 126th mile to the junction of the surveys of Divisions M and N, at 158 miles, the fall of the river is 85 feet, or under three feet per mile by the line which cuts off some of the bends. The gradients on this section are undulating; the heaviest is one per 100, where the line leaves the bank of the river and rises to the higher benches, to avoid land slides and consequent heavy works.

The works on this section of 32 miles will be generally moderate, the heaviest being a cutting through gravel 1,100 feet long, and 35 to 40 feet deep, and crossing a gravel slide 300 feet long. The material from the first would be required for ballast, and the slope of the latter might be cut into, and the material used for the same purpose, or cast into the river. There is a clay slide, 900 feet long, with springs of water in it, which would require drainage and heavy protection works. One bridge of 50 feet span would be required over River No. 2.

From 158 miles to the head of Grand Rapids, the valley is wide, and the flats adjoining the river are low, so that the line does not follow it so closely, but cuts off many of the bends. The fall of the river in this distance, 27 miles, is 50 feet, or less than two feet per mile, and the gradients are easy, with the exception of one of 1·25 per 100 for a mile and a quarter, which, however, may be reduced. The earthworks on this section would, generally, be moderate, the bridging of one river 120 feet wide, and two of 50 feet each.

From the 180th to the 185th mile the valley narrows in towards the canyon at Grand Rapids, and there are no benches, the clay slopes, well wooded, coming to the water's edge. On this portion the earthworks would be rather heavy.

The River Fraser near the Grand Rapids, at the 185th mile, is 2,009 feet above

sea level, and near Tête Jaune Cache, 48th mile, it is 2,380 feet; so that in this distance of 137 miles by the line surveyed, the fall is 371 feet; but, by the river, the distance is nearly 200 miles, so that the average fall is under two feet per mile. In this distance there is one rapid about a mile long, in which the river flows at the rate of about six miles per hour, and a short riffle only visible at low water. By a moderate outlay the river could be made navigable for steamers of light draught the whole of the distance from Tête Jaune Cache. It is 200 to 300 feet wide near Tête Jaune Cache, and increases from 500 to 700 feet before reaching Grand Rapids; at high flood it overflows its banks in some places.

At the head of Grand Rapids, 185th mile, the line leaves the Fraser Valley and takes a general course nearly west, turning the north end of the Cariboo range of mountains: it re-enters the Fraser Valley and crosses the river below its confluence with the Stewart, near Fort George, 245 miles from Yellowhead Pass.

The height of the Fraser at the head of Grand Rapids is 2,009 feet above sea level, and at Fort George it is 1,879 feet; but between these two points the undulations of the land are considerable, as the valleys of Bear and Willow Rivers have to be crossed, and the altitude of the highest divide, which is between Willow River and the Fraser, is 2,445 feet above sea level.

The steepest gradients on this section are 1 per 100, rising and falling, making together an aggregate length of about 19 miles. The longest of these is about eight miles.

The excavations, for the greater part in clay and gravel, would be of no great depth, and may be classed as light and medium work. The rock cuttings, although not deep, are on a rough hillside, and should be classed as heavy works; the following would be about the proportions: Light works 16 miles, medium 24 miles, and heavy works 20 miles.

The bridging would be: Bear River 3 spans, viz., two of 100 feet each 55 feet high, and one of 250 feet over a rocky gorge 170 feet deep. Willow River, one span of 100 feet; Yul River one span of 40 feet.

The next is the Stewart River section, commencing at the Fraser and following up the right or south bank of the River Stewart, on a series of benches 80 to 100 feet above the level of the river to the mouth of the River Chilacoh 15¼ miles. The Stewart falls in that distance 101 feet, or a little over six feet per mile, the height at the mouth of the Chilacoh being 1,980 feet above sea level. The formation level of the line is 2,025 feet above sea level. There is only one gradient of 1 per 100 for three quarters of a mile; the rest are very easy.

The soil is gravel, sandy loam, and clay, covered with small black fir and groves of aspen, with a few balsam trees.

The heaviest work would be an embankment half a mile long and 15 to 25 feet high. Of the balance, 12 miles would be light work, 1¼ miles heavy side hill cuttings, and 1½ miles medium.

The Chilacoh section commences at the junction of the Stewart and Chilacoh valleys, 260¼ miles from Yellowhead Pass.

The line follows up the latter valley 38 miles, in which the rise is 350 feet, and there is only one gradient of 1 per 100 for a mile and a half, in rising to the canyon between the 280th and the 281st mile. The rest of the gradients are very easy.

The earthworks throughout this section would be light—nearly all in alluvial deposits; but the river, 60 feet wide, meanders from side to side of the valley, causing heavy land slips where it strikes the slopes. To avoid these, it will have to be bridged several times, and at some places diverted, so that the work may be classed 30 miles medium, and 8 miles rather heavy.

The point on the plateau where the line leaves the Chilacoh valley, at 298 miles, is 2,375 feet above sea level, and from this, over the divide and down to the bottom flat of the Blackwater the distance is 20 miles, on which the gradients are undulating, the highest being 40 feet per mile. The line crosses the telegraph trail near the 310th mile from Yellowhead Pass, at an elevation of 2,660 feet above sea level. The

highest point of the divide is 2,686 feet, at 313 miles. On this section there would be three miles of rather heavy earthworks and the balance would be medium.

It is probable that by a deviation of the line further to the west it could be shortened three or four miles without materially increasing the gradients.

The height of the last point, in the valley of the Blackwater, is 2,535 feet above sea level, thence the line follows up that valley to the mouth of the Nazco River, near the 332nd mile, which is 2,755 above sea level, thus rising 220 feet in the 14 miles, with variable but easy gradients.

Of this length 6½ miles would be in rock cutting, and consequently the work would be heavy; on the balance of the distance, the work would be medium; the bridging of the Blackwater would be about 150 feet in length.

From this, the survey was carried up the Blackwater valley 70 miles, the general course being a little to the south of west; thence it made a sharp angle to a south-easterly course across a high divide to the Cluscoh Valley.

But it is proposed to carry the line up the Nazcoh Valley so as to cut off this angle, by which a great saving in distance will be effected. This is now ascertained to be practicable, the summit of the divide being 3,700 feet above sea level and the ground favourable.

This would rejoin the line surveyed about 402 miles from Yellowhead Pass, at a point a little to the north-east of Chisicut Lake, in the Chilicotin Valley, 3,422 feet above sea level.

The character of the works in this section can only be ascertained by an instrumental survey.

The line then descends the Chilicotin Valley with easy gradients, crossing the river between the 406th and 407th mile, at an elevation of 3,300 feet above sea level. At the 409th mile it begins to ascend the western slope of the valley obliquely, reaching the summit of the divide between it and Puntzee Lake, near the 415th mile, 3428 feet above sea level. The highest gradient is about 32 feet per mile, and on the whole of the section from the 402nd to 415th mile, the works would be medium. The bridging of the Chilicotin River would be 100 feet clear water way.

From the summit of the divide, the line descends with a gradient of 1 per 100 for three and a half miles, and 0·70 per 100 for the rest of the distance to the margin of Puntzee Lake, on its north side, at 421 miles, which point is 3,190 feet above sea level. In the whole of this six miles the cuttings and embankments would be rather heavy; a portion being in rock and the rest in gravel.

From this the line follows round the north side of Puntzee Lake to its west end; thence across the low divide to the Chilancoh Valley, where it joins the survey of Route No. 4 at 439½ miles by that survey, and 431½ miles by the present survey from Yellowhead Pass.

In this last section, the gradients are undulating, the highest being 1 per 100 for nearly two miles in crossing the divide between Puntzee Lake and the Chilancoh Valley. The works on this section would be medium; the bridging of the Chilancoh 60 feet in length.

The rest of the line down to the head of Bute Inlet is described in my Progress Report, 1874.

The line shown on the Diagram as Route No. 8 branches out of the last at a point in the Blackwater Valley, and takes a course nearly due west to the valley of the Kamsquot or Salmon River, and follows the same to its outlet on the south side of the Dean Channel. This has been partly examined and promises favourable gradients; and though there would be some very heavy work in the heart of the Cascade Mountains, I think the line merits consideration, and may be well worth the cost of an instrumental survey.

Abstract of work done in 1874.

The information gained from the surveys and explorations of this last season completes our general knowledge of the country from the American boundary line

or 49th degree of north latitude to a parallel between the 56th and 57th degrees, and from the Pacific coast to the plains east of the Rocky Mountains.

We have crossed the Cascade chain of mountains by nine different lines; of three of those we have made complete instrumental surveys—one we have partly surveyed, and of the others we have made track surveys with compass and barometer.

We have made two instrumental surveys through the Rocky Mountains; one of them, by the Yellow Head Pass, has been carried eastward to a point within 130 miles of Edmonton, on the river Saskatchewan. The Peace River Pass has been examined, and a party left Fort George about the beginning of the present year to explore the Smoky River Pass, (the next north of the Yellow Head). They may be expected in Winnipeg some time in May next.

We have ascertained that the central plateau has a general uniformity of altitude, from the 49th parallel to the 54th parallel of north latitude, varying from 3,500 to 4,000 feet, but traversed by irregular ranges of hills rising up to 1,000 feet higher. South-east of the Fraser the rivers and lakes are sunk deep into the plateaux and the slopes of the valleys and hills are generally steep rocky escarpments. North-west of the Fraser all the river and lake beds are more than 2,000 feet above sea level—except for a short distance up from their confluence with the Fraser. There is generally more breadth of bottom flat in the valleys, and their slopes are not so steep and broken, so that there is little difficulty in finding a favourable line for the railway through any of them. Even the intervening hills and plateaux, though rising often a thousand feet above the level of the valley, are tolerably uniform, and rock seldom appears on their surface, except when near the Cascade Mountains, or when crossing a range of more than average height.

We have also traced the course of the watershed or divide between the streams falling eastward into the Fraser and westward into the tide waters of the Pacific, or southward into the lower Fraser between Hope and New Westminster. This divide, commencing at Yale, nearly north-west on one of the superior ranges of the Cascade chain extending to the head of Tatla Lake, near the 52nd parallel of latitude, and about 124° 45' of west longitude. This is at the head of the Homathco Pass, and the height is 3,117 feet above sea level. From this point, it runs nearly due north to the 53rd parallel of latitude; crossing the heads of the Bella Coola and Kamsquot or Salmon river to a point between the north branch of the latter and the head of the Blackwater valley, 3,720 feet above sea level.

From the last point, the divide turns nearly at right angles, and runs across three degrees of longitude, regaining the crest of the Cascade Mountains about 127½° west; thence it follows the crest of the mountains nearly due north to a point beyond the head of Lake François, which lies on the 54th parallel of latitude. In this last course there are two depressions or passes; one nearly opposite the head of Gardner Inlet being 3,050 feet above sea level; the other is farther north, at the head of the river Kemano, altitude 4,100 feet above sea level.

These are the only passes between the Salmon and the Skeena rivers, and their summits are so near the tide waters of the Pacific that the descent to the same is very steep, and the mountains from the coast look like an almost perpendicular wall of rock.

Either of these two passes may be reached from Fort George—on the River Fraser—by the Stewart and Nechaco rivers and Lake François; but the valleys of these rivers and the shore lines of the lakes are so tortuous that the distance to the Pacific coast would not be less than by the line surveyed to Bute Inlet, and the works in constructing a railway would probably be heavier.

The Yellow Head Pass is the best for the railway that has yet been found through the Rocky Mountains, but all attempts to find a favourable line between this and any pass west of the River Fraser had not, until this last season, been very satisfactory. It was therefore determined to try a line from Tête Jaune Cache down the valley of the Fraser to the Grand Rapids; thence westward across the north end of the Cariboo range, crossing the Fraser above Fort George; thence by a series of

valleys across the central plateau to the Homathco Pass, and through the same to Bute Inlet. This is Route No. 6.

This survey has been successful. A very favourable line has been found, 34 miles shorter than estimated last year; so that the route to Bute Inlet will now bear favourable comparison with the more southern routes terminating at Burrard Inlet. The line branching out of this and running nearly due west to the valley of the Kamsquot or Salmon river, thence down the same to a point on the east side of the Dean Channel, promises gradients through the Cascade Mountains so favourable that it may be considered worth the cost of an instrumental survey,

Yours, &c.,

MARCUS SMITH.

Sandford Fleming, Esq.

Engineer in Chief.

Canadian Pacific Railway.

APPENDIX G.

REPORT ON EXPLORATIONS FROM DOUGLASS, GARDNER, AND DEAN INLETS, EASTWARD IN THE CASCADE MOUNTAINS; BY CHARLES HORETSKY.

BELLABELLA, NORTH-WEST COAST, BRITISH COLUMBIA,
November the 15th, 1874.

SIR,—Having in view the verbal instructions of Mr. Fleming, and the written suggestions made by yourself, while on board the "Otter," during her voyage up the Gardner Channel, I left that vessel at 4 a.m. on the morning of the 8th June last, to join the sloop Triumph, then lying at anchor in the Bay of Kemano. The Indians to whom I had previously spoken, and who promised to join me at this place, did not make their appearance until the 10th, and I was only enabled to begin the exploration of Manson's route on the 11th.

My party consisted of two white men—engaged in Victoria—and four Indians from the Kitlope village. We proceeded up the Kemano River, a distance of ten miles, by canoe, having to contend against a very swift current in which the poles had to be used from the outset. The valley of the Kemano is from half, to three quarters of a mile wide, and is walled in on either hand by huge and precipitous masses of gneiss and granite. The river flows through a low and uniform bottom composed of sand and boulders, covered by a thin stratum of vegetable mould which supports a growth of spruce, balsam, poplar and cedars. The stream is split up into many channels, immense piles of drift wood obstructing the navigation, and bearing witness to periodical freshets of great volume. Immediately above the confluence of the Penteuchltenay, a stream flowing into the Kemano from the north-east, and up which my route lay, we landed the canoe, packed our provisions, and proceeded on. Hitherto, the rise had been but trifling—190 feet in ten miles—but, on commencing the ascent of the Penteuchltenay a mere mountain torrent, the ground rose so abruptly that I quickly became convinced of the impracticability of the route. I, however, determined to proceed as far as the watershed, so as to obtain an idea of the elevation of the plateau in rear of the range. Manson's old trail being but seldom visible, the ascent sharp, and numerous obstacles obstructing our way, we advanced slowly. Three miles above the canoe encampment, we came to a heavy snow-slide originating from the heights on our left. This avalanche had cleared a passage through heavy green timber, snapping stout spruce trees off, short, close to the ground, and now, not only filled the bed of the stream, but had actually reached a considerable way up the opposite side of the ravine. As we advanced, similar avalanches were passed, and wherever they had taken place, fragments of rock and debris of timber strewed the ground in the vicinity. Besides these very serious obstacles, slips of the rocky masses above appeared to be of frequent occurrence, large quantity of rocky fragments lining the river, and greatly hindering our progress. From these causes it was quite evident that, at certain periods, the passage of this ravine must be attended with considerable danger. Towards the head of the ravine, glaciers began to appear. Eleven miles above the canoe camp, the ground rose very abruptly indeed, and three miles further on, the Summit Lake, situated at an elevation of 3,769 feet above the sea level, was reached. It will be thus seen that, in a distance of 14 miles, we had ascended 3580 feet, an extremely steep rise, and quite unavoidable. The Penteuchltenay is fed principally by the Summit Lake, immediately below which, the ravine closes entirely, in the form of a semicircle. Upon reaching the summit Lake, an irregular sheet of water covering an area of three quarters of a square mile, we found it yet icebound, but dangerous. We were in consequence obliged to scale the high mountains on the east side, and, after a

difficult and hazardous walk over huge snow banks, covering at intervals, ravines of treacherous depth, where a slip would have endangered both life and limb, we finally descended to and reached the Summit—4,114 feet above sea—and situated one quarter mile east of the lake. Here snow covered the ground to a great depth. From this point we beheld a scene of surpassing grandeur. Southward, a perfect sea of glaciers obstructed the horizon, while to the east, a precipitous descent led to a deep valley 1,200 or 1,300 feet beneath. Bald, rugged mountains terminating in peaks elevated 3,000 to 4,000 feet above the eye, towered above huge glittering masses of ice held in their vast chasms. A terrible silence, broken only now and again by the dreadful crash of some falling avalanche, reigned over this scene of desolation.

In a distance of two and a half miles from the summit, we reached the "First Lake" of Manson's report, situated betwixt two of the spurs of the range in the valley above mentioned, and at an elevation of 2,863 feet above sea level. Into it flows a large, glacier-fed stream from the south, the lake waters draining towards the north-east, and probably joining the Nechaco.

From this point I determined to retrace my steps, as the nature of the ground gone over appeared to render a journey to Lac des François, by this route, useless. Returning, I had an excellent bird's-eye view of the narrow ravine of the "Pen-teuchltenay," from a point slightly south-west of the Summit Lake, and was also able to distinguish the sloop at anchor in Kemano Bay, bearing south 29° degrees west magnetic, and distant about twenty-four miles. I returned to the sloop on the 17th June, having been absent nearly seven days.

The Bay of Kemano is situated on the north side of the Gardner Inlet, about sixteen miles from the Kitlope River, and in latitude 53° 31′ 30″ nearly. It is about one mile deep and three-quarters wide. Adjoining there is very little available land.

It having been understood in the course of our conversation on board the "Otter" that the examination of the Kitlope river might be deferred until the close of the season, I now expressed a desire to Mr. Richardson of the Geological Survey that we should, at once, proceed to the Kitimat, that gentleman having by this time, completed his researches in this locality. We accordingly weighed anchor on the evening of the 19th for the head of the Douglas channel. Clio Bay was reached on the morning of the 21st, calms and baffling winds prevented our reaching the lower village before the afternoon of the 22nd, and it was not until the morning of the 27th June, that I was enabled to start inland. Before going further, it is necessary to briefly describe the head of this Inlet. Kitimat Inlet, a continuation of Douglas channel, terminates in about latitude 54° 0′ 0″, and here, a large stream of the same name, enters it. South of this river's embouchure the estuary is several miles wide, with bold rocky shores, and is very much exposed to southerly winds. North-east from the river mouth there is a pretty large bay blocked up at the entrance by a vast accumulation of silt derived from the river, but through which, and closely hugging the east shore, a narrow and shallow channel affords an entrance for small craft. In the immediate neighbourhood the ground is low, especially on the north side, where the wide, level valley of the river begins. This valley is about four miles wide, and extends for a very long distance northward. From an elevated position I had a very fine view of it, and I am tolerably certain that easy ground intervenes between the head of this Inlet and the Skeena river. I may remark that, in no other locality, during the season's operations, did I see such an extent of level land.

Having, after much delay, engaged Indians, I put up provisions for sixteen days, and started in search of a pass to the eastern plateau. I must remark that not a scrap of information could I obtain from the Indians, who made the most contradictory statements regarding routes, and at the very outset, led me entirely astray, persuading me to take the right hand branch of the river. Up this stream we poled, and at a distance of eleven miles from tide water were obliged to abandon the canoes, the river being no longer navigable. I need not enter into a detailed account of this journey, the section shewing the impossible nature of the valley, which soon became a mere ravine terminating in the usual

semi-circular form, and leading only to the nucleus of the range. From the source of this stream I, however, discovered indications to the north-west, of a route through the apparently impenetrable maze of mountains, and hastily returned to tide water for the purpose of fitting out afresh for an exploratory journey up the main Kitimat.

From the 6th July—the date of my return—until the 17th, it rained so persistently that it was out of the question to attempt the ascent of the River Kitimat, now so much swollen by the heavy rains that its navigation had become hazardous. On the morning of the 17th we set out again, poling the canoes against a stiff current, and reached the fork of the Lachaques, six miles from the sea, in three hours. In this lower portion of the stream the channel had undergone some change in its appearance since our last journey, the late freshet having swept away sundry drift piles, new ones being deposited in other places; the water had, however, fallen very rapidly, so that we made fair progress.

Following the main stream for twenty-two miles northward, through a wide and uniform valley, in which, during this distance, the average grade of the river was nearly 15 feet per mile, we took a sudden bend to the right, the stream now flowing through an opening in the hills forming the eastern boundary of the main valley. For a mile or more this lateral valley was narrow, but practicable; it then widened for a short distance, and again became contracted, until, when 12 miles from the "Bend," it widened to the extent of a mile, and so continued to the head of navigation, forty-one miles from tide water, where the elevation of the river bed is nine hundred feet above the sea, and whence, to the twenty-third mile, the average inclination is thirty feet per mile. At this point, a ridge or saddle stretches right across the valley, and through it the north, and two other forks, cut their way in rocky canyons. Below this, the level portion of the valley is nowhere much elevated above the river bed, the banks being generally from six to ten feet high, and of a sandy, gravelly nature, the counterpart of the Kemano.

At the lower end of the canyon of the north fork, we hauled up the canoes and camped for three days, during which the rain poured in torrents, rendering it impossible to move. After almost fruitless endeavours to discover the general topography of this unknown region, we struck over the ridge, following the north fork, which, above, flowed through a steep and narrow ravine encompassed by mountains of g reat altitude, and alone gave hopes of leading to a pass through the Cascades, the other branches having already been recognized as those I had seen and traced to their sources in glaciers, from a high mountain near the source of the Lachaques. For ten or eleven miles more we followed this stream to its source in a glacier, 3,000 feet above sea level. At this point, abrupt mountains walled in the head of the ravine, while, beyond, to the eastward, still higher masses barred the way. From the forty-first to the forty-eighth mile, the mountain slopes are very precipitous and subject to rock slides. From the forty-eighth to the fiftieth mile the ravine bends sharply to the north, becoming still more contracted, and rising in that distance about eleven hundred feet. Two miles higher up is the glacier source already mentioned, surrounded by mountains elevated 2,000 feet and upwards, above it. How far these mountains extend to the east, I do not know, the fog and rain which prevailed preventing a view in that or any other direction.

A profile of this journey is herewith furnished. No photographs were taken, the never-ceasing rain rendering it impossible to use the photographic plates. This is to be regretted, as a view of the terrific scenery near the source of the North Fork would have better described that region than it is possible for me to do here. I may mention that to obtain this view no efforts were left untried, the camera having been taken up to an elevation of more than 5,000 feet for that purpose, but a blinding storm of hail put an effectual stop to any attempt in that direction. From the same causes, observations from the latitude had to be abandoned, and after waiting as long as possible for an improvement in the weather, I returned to tide-water, rejoining the sloop on the 30th July.

Immediately, or not very far east of the Glacier Source of the north fork of the River Kitimat, the Indians tell me that, when hunting sheep on the mountains,

some of them had seen a rapid little stream flowing north-westward towards the River. Skeena * * * * * * *

On the 31st July, we took our final departure from the "Kitimat," anchoring for the night at the lower village. The next morning, at 3 a.m., we weighed for Bellabella, where, owing to the calms and adverse winds, we did not arrive until the evening of the 8th August.

Mr. Richardson, of the Geological Survey, being now desirous of returning to Victoria, it was arranged that he should take passage by the "Otter," and that I should proceed with the sloop to the head of Dean Channal. Accordingly, I left Bellabella on the 12th, reaching the "Tsatsquot" River (at the head of the channel) only on the 19th, being delayed by calms and baffling winds. At this place I at once engaged Indians, and leaving the sloop in charge of Captain Douglas and James Anderson—the latter being instructed to keep an hourly meteorological record, with the special object of noting atmospheric fluctuations at sea level, with which to compare my own barometric observations inland—I left for the exploration of the Tsatsquot River and Valley on the 20th August.

By repeated observations of the sun's meridian altitude, the mouth of the River Tsatsquot, at the head of Dean Channal, has been found to be in north latitude 52° 52′ 30″ nearly; a result corresponding very closely with Vancouver's. The valley of the river, a huge trough, of which the bottom is covered by a vast deposit of sand and boulders derived from the mountains, and which has unmistakably been filled at some remote period by a vast glacier, is barely one mile wide at its lower end.

Mountains of granite and stratified rock, 5,000 feet and upwards in height, perpetually snow-clad, and holding in their elevated ravines and clefts glaciers of varied size, encompass it. Upon the lower stratum of sand and gravel, a thin layer of vegetable mould supports a growth of spruce, cedar and other woods, which, in the vicinity of the stream, are in great quantity, periodically undermined, and washed down by the fierce spring and autumn freshets.

The river is divided into many channels. Bars of gravel intercept the drift wood, and great piles of the latter are often accumulated. A great part of the level portion of this valley is subject to flood, and it is generally only in close proximity to the mountain slope that immunity from this drawback can be obtained. For about fifteen miles we poled up this stream, generally northward, reaching the "Bend" in a little less than one day and a half. At this point the valley turns sharply to the north-west, and becomes very much wider. At the "Bend" the elevation of the river bed is 525 feet above sea, and the grade thence to tidewater nearly 34 feet per mile. For the purpose of ascending this dangerous river, shovel-nosed canoes are employed, and great skill is necessary to surmount the numerous and dangerous rapids. By rough measurement the discharge per second at this "Bend," during a rather high stage of water, was calculated to be about 5,600 cubic feet; but in extraordinary freshets nearly double that quantity must be discharged.

At a distance of about twenty-four miles from the sea (where the river bed is 742 feet above that datum) we were obliged to abandon the use of the canoes and to proceed on foot. From the "Bend" up to this point the river is less rapid, and the valley probably two miles wide in places. About one mile below the head of navigation we passed the middle branch, that on which we were being the north fork, to the source of which we were now to proceed. From the canoe encampment a walk of two miles brought us to where the north fork issues from its deep and rocky canyon into the main valley, of which the elevation is here 978 feet above sea. The Indian trail now left the low ground, winding up a steep ascent, and after a sharp climb we reached an elevation of 3,000 feet above sea, being now on the northern heights above the main valley. Our way was to the north-east and north, the north fork being on our left but completely hidden from view in its deep canyon. For several miles we kept on, finally reaching the bed of the north fork, at a point where its elevation above the sea is 2,930 feet. Half a mile farther the summit was reached—3,000 feet above the sea. A little further on we arrived at the

Summit Lake—3,000 feet above the sea—whence the waters flow eastward into Lake of the Mists, situated about half a mile more to the north, and elevated 2,990 feet above the sea level.

At this Lake we found three wretched cottonwood canoes, and embarking therein we proceeded to the lower end, where we camped upon the portage between Lake of the Mists, and Lake Talchelkin. Bad weather now set in, and during thirty-six hours it was impossible to move out of camp. An examination of the vicinity was afterwards made, sundry views were taken, and we retraced our steps on the 27th August.

I now give the following notes in reference to Lake Talchelkin, Lake of the Mists and the north fork of the Tsatsquot, which, with the section, map and photographs, will describe all that is necessary regarding this route:—

The lower end of Lake of the Mists is situated in about latitude 53° 17′ 30,″ the result of a meridian altitude of the sun on the 26th. This lake lies North 20° W., and South 20° E., between very high trap and granitic mountains. It is about one and a half mile long, and three quarters wide, and evidently of very great depth on the west side. At the north, or lower end, its surplus waters flow into "Lake Talchelkin" by two outlets. The distance between the lakes is one quarter mile, the dividing ridge being low and rocky. The difference in level is 98 feet, Talchelkin being 2,892 feet above the sea, and the lower. From a point on the mountain slope south-west of the portage, between the two lakes, I photographed all that was visible of the Lake Talchelkin. The view includes the country 15 to 20 miles distant, lying north and east of the lake. Beyond this distant land, which is low and undulating, although mountains are visible in the blue distance, the Indians say that the country is quite easy in the direction of Fraser River. About seven miles from the portage Lake Talchelkin turns to the east and south for a long distance, and would appear to closely hug the precipitous mountains lying in that direction. A few miles north of Talchelkin, and separated from it by a north-eastern offshoot of the Cascades, lies a very large lake, named by the inland Indians, "Nateltichen," Beyond the central point in the photographs this spur or offshoot breaks away, and a low narrow strip of land, over which the Indians carry their canoes in one trip, is all that separates those two large lakes.

Lake Nateltichen lies generally about east and west; it, like "Talchelkin," is fairly out of the "Cascades," and drains to the north-east.

The north fork of the Tsatsquot derives its waters from an immense glacier situated immediately west of the "Summit Lake," and is separated from the latter by a wooded ridge. For three or four miles this stream flows due south, then south-west, finally emerging from its deep ravine into the main valley at a point eight or nine miles distant from the Summit Lake, and 2,072 feet below the summit level. From the 32¾ mile on the profile, downwards, the descent of the north fork through a deep and rugged canyon is very abrupt and impracticable for railway construction * * * * * * *

I returned to tide-water on the 31st August, and prepared for another journey up the middle fork of the Tsatsquot, notwithstanding the asseverations of the Indians, who protested I should find nothing there. I was about to start upon the 4th September, when heavy rains set in, lasting without intermission until the 8th, and on the 9th I again ascended the Tsatsquot. We now took the middle fork, which we found navigable as far as the confluence of a tributary from the south-west. Here we cached the canoes and moved north-westward. We at length reached a low watershed in the valley (1,200 feet elevation), and crossed the middle fork which now came from the mountains on our right, and a short distance further, reached a lake three miles long, and walled in on either hand by high, wooded, bluff mountains.

"Beaver Lake," (the name I have given to this sheet of water) lies in the same direction as the Tsatsquot valley, in which it may be said to be, although its waters flow into the north-west branch of the River Kitlope, and in a direction opposite to that of the middle fork of Tsatsquot. The elevation of this lake is about 1,100 feet above sea level, its lower end is in latitude 53° 14′ 45″, and at this point, a rapid

mountain torrent from the northward, enters it. This stream, the north-east fork of the Kitlope, has its source in a glacier distant about seven miles from the lake. A mile or so east of this glacier source, I discovered a pass through the comparatively low mountains forming the rearmost longitudinal mass of the Cascade range. This pass presents direct communication between the upper part of the ravine of the north-east fork of the Kitlope, and a beautiful sheet of water situated on the eastern plateau amidst the outlying spurs of the mountains, and to which I have given the name, "Lake Tochquonyala." This lake is situated at an elevation of 2,920 feet above sea level, its upper end is in latitude 53° 20′ 13″ nearly, and it discharges into Lake Nateltichen, to which I have already referred, and of which the elevation very probably approximates to that of Lake Talchelkin, 2,802 feet.

Having camped on the left bank of the north-east fork of the Kitlope, at an elevation of 2,900 feet above the sea, I ascended the mountain on the west side of the pass, and from an elevation of 5,000 feet above sea, I obtained a view of the grandest and most varied kind it had yet been my fortune to witness. In a direction east by south, the ten miles of intervening space between my present position and the old camp at Lake Talchelkin (which was not visible), was filled by a perfect sea of conical peaks and rugged moutains, all snow-capped, and abounding in glaciers. Here and there in the heather-covered hollows, a tiny lakelet glistened and reflected the huge shadows of the frozen peaks above. Turning to the south-west, a large flat glacier, of probably half square mile area, and two hundred feet in depth, lay a little way beneath me, discharging from its lower end the dirty waters of the north east fork, which could be traced like a silver thread, as they rushed down the steep ravine to Beaver Lake. But in the direction of the north-east, the scenery was of a quite different description. A country, still in the immediate vicinity, rough and broken, but a little way off, low, undulating, and even hilly, stretched until lost to view in the hazy distance, the dark forest which covered it, relieved by the bright waters of "Nateltichen." on which a solitary wooded island cast its shadow. In closer proximity, Lake Tochquonyala lay at my feet, calm and unruffled, the shadows of the eastern hills brightly reflected upon its deep waters. By singular good luck, I was enabled to photograph this remarkable scene, and returned to camp, after having taken all the necessary bearings.

We now experienced the want of canoes, with which, in a few hours I could have satisfied myself as to the nature of the south shore of Lake Nateltichen, which was entirely hidden by the mountains at the lower and east end of Lake Tochquonyala; but one of my Indians assured me that it was not by any means abrupt.

From the south-west end of Lake Tochquonyala, through the pass, to the ravine of the north-east fork of Kitlope, the distance is about one mile and a half, and about midway the ground rises to an elevation 260 feet higher than the lake level.

The prevailing rock on the east side of the pass is coarse granite, but on the other, stratified rock of a softish nature composes the mountains. The waters of the north-east fork of the Kitlope reach Beaver Lake after a precipitous descent through a rugged canyon above which the mountains rise to towering heights. From Lake Tochquonyala to the lower valley of the Tsatsquot, a road could be carried only along the rugged slopes at a high elevation and with excessively steep gradients * * *

On the evening of the 29th September, after having been delayed for more than a week by very heavy rains, I returned to the sea, and the season now drawing to a close, I determined to send the sloop back to Victoria. On the 2nd October, the sloop was moved to an anchorage in Kamsquot Bay, and, after taking in ballast, left for Bellabella on the 5th, my two men and myself taking up temporary quarters in the Indian village situated at the mouth of River Kamsquot, otherwise known on the map as the Dean or Salmon River.

This stream appearing on the map to be of great length, I now deemed it my duty to follow it up, but heavy rains setting in, and continuing up to the 11th, so raised the river that I was obliged to await its subsidence, and was only enabled to start on the 13th, Anderson being left in charge of our property, and entrusted with

the meteorological record. On the 22nd I returned to tide water, after having ascended the Kamsquot for a distance of 35 or 40 miles.

The River Kamsquot enters Dean Channel in about latitude 52° 48′ 30″, and six or seven miles south-east from the termination of the inlet. It issues from the high mountains on the east side, and from a canyon several hundred yards in length; after which it follows a circuitous channel for two miles more, reaching sea level at the Indian ranche of the same name. It is a very rapid river, discharging a considerable volume of water, derived partly from glacier fed tributaries, but chiefly, according to Indian report, from a lake of moderate size in rear of the Cascade range. The volume of water discharged per second into the sea by this river during high freshets has been roughly estimated to be 25,000 cubic feet.

Immediately below the valley of the Kamsquot, and west of the rocky canyon, there has been formed, (very probably in great part by ancient glacial action) a large level spit composed of closely packed sand and gravel, projecting into the deep waters of the inlet, and almost reaching the opposite shore. This low ground comprises an area of about 1¾ square miles, all of it available for either agricultural or other purposes. North-west from this spit of land, there is an extensive bay capable, as to size, of accommodating almost any quantity of shipping, but, unfortunately, the water is so deep that hardly any anchorage is obtainable.

The canyon from which the Kamsquot is said to emerge, before reaching the sea, has been eroded through a rocky spur or saddle, which formerly blocked up the narrow valley above it. The Indian portage trail from the ranche to the upper end of the canyon has been made over this rocky spur, and at its highest point is 450 feet above sea level, and about 270 feet higher than the valley at the head. For a long distance up, the valley presents unmistakeable marks of glacial action; everywhere the rocks are scratched and deeply grooved, the very trail over the spur actually following a series of well-defined grooves for several hundred feet. The hypothesis that, previous to the formation of the canyon an ancient lake barred in at the lower end by this rocky spur filled the present valley, is quite reasonable. From the head of the portage to where the Indian trail to Lake Talchelkin, ascends the steep mountain towards the north-east, the distance is about eight miles, in which the breadth of the valley rarely exceeds half a mile, and the low bottom, exactly similar to that of the Tsatsquot, is greatly subject to overflow during high freshets. From the Talchelkin trail, where the river bed is 370 feet above sea level, to the head of canoe navigation, distant 15 miles from the upper end of the portage, and where the river bed is 621 feet above the sea, the valley trends generally eastward, becomes slightly narrower, but presents no insuperable obstacles. Above the head of navigation, the term "valley" is hardly applicable to the narrow ravine through which the Kamsquot flows. Curiously enough, however, gravelly benches of diminutive size are met at intervals, in nearly the whole distance from the head of navigation to the Salmon House, twenty miles higher up. These benches are very irregularly disposed; of trifling extent in width and length; break off very abruptly; are at different levels, and would offer but few facilities to a road. Our progress during this part of the journey was slow and laborious. At one moment we followed a bench for several hundred feet, then an abrupt talus of sharp rocky debris from the mountains above would cause us to descend to another terrace which generally ended abruptly in the most tantalizing manner. Sometimes, and indeed for long distances, we kept the river margin, where the round slippery boulders, bad as they were, afforded better walking than the broken ground and tangled underbrush a little higher up. As we advanced, serious and dangerous rock-slides became of frequent occurrence, and I gradually began to lose hope of finding a practicable route in this direction. When about 26 miles above the head of the Canyon portage, the high snow peaks of the Cascade range were no longer visible ahead, and we seemed to be passing, if we had not already passed, the core of the range. Six miles below the Salmon House, the rock slides became of almost constant occurrence, with intervals of gravel benches, and hence, upwards, the nearly continuous talus of loose rocks, extending in many places from water margin to great heights,

presents a formidable obstacle to the construction and permanance of a road. Some distance below the Salmon House, the Kamsquot flows through a rocky canyon, passing beneath the house at an elevation of 1,300 feet above the sea, the house itself being perched upon a rocky eminence 140 feet above the river. Northward, in rear of the house, the Indian trail ascends a steep and dangerous rock slide, and speedily attains an altitude of 3,000 feet above sea level. From this high ground a very fair view of the surrounding country was obtained. To the east it is densely wooded, and of the same general elevation, but very rough, and broken up into ravines and gullies. Here I seemed to have reached the plateau, being quite in rear of the main chain of the Cascades, of which, to the south and south-west, the huge needle shaped pinnacles stood in bold relief against the sky. The Kamsquot River was altogether lost to view, but its general direction to the north-east could be traced by its deep ravine. Above the Salmon House, the river flowed in a perfect canyon, very much below the level of this excesssively rough country, and its exploration at the now late season appearing to offer great difficulties owing to scarcity of provisions, I deemed it advisable to abandon further search, and retraced my way to the sea.

*   *   *   *   *   *   *

I reached Bellabella on the 8th November, and after waiting several weeks for the United States steamer "California," left for Vancouver Island in an open canoe, the voyage terminating on the 7th January.

I have the honour to be, Sir,

Your obedient Servant,

CHARLES HORETSKY.

SANDFORD FLEMING, Esq.,
Chief Engineer,
Canadian Pacific Railway.

NOTE.—A general description of the coast from Douglas Channel to Queen Charlotte Sound follows, this, however, is treated of in another appendix.

APPENDIX H.

REPORT ON EXPLORATION ACROSS THE ROCKY MOUNTAINS BY SMOKY RIVER PASS, BY E. W. JARVIS.

WINNIPEG, MANITOBA, 24th May, 1875.

SIR,—Having received your instructions by letter and telegraph, with reference to the exploration of a pass said to exist through the Rocky Mountains at the head waters of the Smoky River (an important branch of the Peace River, and so named from the smoke arising from burning seams of coal near its mouth), I made the necessary preparations for an extended winter trip, and left Quesnelle mouth, B.C., on the 9th December last, with one assistant, one dog driver, and an Indian boy as cook. As the River Fraser was still open, I followed the "Telegraph" trail to the crossing of Blackwater River, and thence the trail opened by Mr. Bell, last summer, to Fort George, where I procured dogs from the Hudson's Bay people. After some delay in obtaining Indians to accompany me, and endeavouring (unsuccessfully) to procure a guide, I finally left Fort George on the 14th January, the ice on the Fraser River having only set fast during the intense cold of the preceding week. The party now consisted of eight men and six dog-trains, carrying provisions calculated to last two months.

A few miles above the Giscome Portage I left the main river, and, following the "North Fork," kept as nearly as possible to the line marked "Unexplored Route" on sheet No. 8 of the plans accompanying your report of January, 1874. Where the stream again divides I took the left hand, or North Branch (as it appeared to offer greater facilities for a line), and followed it to its source, a semi-circular basin in the heart of the Rocky Mountains, completely closed in by glaciers and high bare peaks. As there was evidently no pass in this direction, I returned 50 miles to the Forks, and decided to try the South Branch. From this point, in the middle of February, I sent two of my Indians with two of the hired trains to Fort George, and wrote to you by that opportunity. The party, now reduced to a minimum, was put on regular allowance of provisions, and I enjoined on everyone the absolute necessity of strict economy both of supplies and time.

For the first 48 miles from the "Forks" the valley of the South Branch was very favourable to an easy line, and though at that point it turned sharply to the north-east and entered the main range of mountains, the stream still continued to rise with very easy grades. The valley here was half a mile wide, with the hills rising at a slope of 1 to 1 on each side, and thinly timbered with spruce, black pine and a few poplars. At 71 miles from the "Forks" (or 169 from Fort George), the mountains close in, and in a distance of eight miles the river rose from an altitude of 3,200 feet above the sea to 5,300 feet, at which elevation, four miles further on, I reached the summit lake and crossed the divide on the 25th February.

Although the altitude of the pass at once showed it impracticable for railway purposes, I decided that, having gone so far, I would push on to the River Athabasca, in order to obtain some topographical knowledge of the country lying between it and the mountains; and, accordingly followed the river running east from the divide for 87 miles, which I believe to be the head of one branch of the Smoky River. Here it turned away to the north-east, and I considered it useless to follow it any farther, my object now being to reach the River Athabasca as soon as possible, and seek relief at one of the Hudson's Bay Company's posts on that river.

Having lost several of my dogs (from frostbite and exhaustion), I was obliged to make a cache of my instruments, &c., and leaving everything not absolutely neces-

sary at the cache, we started overland in a south-easterly direction, each carrying his blankets and his share of the provisions. After 108 miles of very difficult travel over a terribly broken country, crossing high parallel ridges and the intervening valleys (in all of which the water runs north-east, or in a similar course to the Smoky River and the Athabasca), and which occupied no less than 11 days, I reached the "Fiddle River" depôt, built by Mr. Moberly, intending to obtain at Jasper House a fresh supply of provisions, now nearly exhausted, to carry us to Edmonton. The Company's post was, however, abandoned; but I was fortunate enough to fall in with some Indians in the neighbourhood, from whom I procured sufficient to last for six days (at one pound per man per day), but which I economized for ten days; and leaving the remnant of my half-starved dogs in care of the Indians, we shouldered our packs and marched to Lake St. Anne, where we arrived on the 30th March, having lived the last three days on the anticipation of a meal at the journey's end.

Between Fiddle River and Lake St. Anne I followed a line of country some miles to the north of the line run by Mr. Moberly, and north of the old H. B. trail. A good location can be got here. I was unable to explore a line from Root River to White Earth (old) Fort, as you directed, owing to extreme bodily exhaustion consequent upon the hardships we underwent.

From Lake St. Anne I drove to Edmonton, and as the winter season was so near its close, I decided to proceed here as rapidly as possible, so as to be in time for the summer's work. I travelled from Edmonton to Victoria with flat sleds and horses; and to Fort Pitt I packed the animals, as the snow already showed signs of going. From Fort Pitt I took carts to Carlton, but my progress was much impeded by the return of winter with freshly fallen snow. At Fort Carlton I remained four days, to rest the horses and wait for the appearance of some bare ground, and leaving there on the 5th inst., reached Winnipeg on the 21st.

The accompanying plan shows the route followed, and may be taken as tolerably correct, the distances all being paced from Fort George to Lake St. Anne. Observations for latitude were taken with the sextant, and with boiling-point thermometer for altitude, as far as the cache on Smoky River; but since then the aneroid and compass alone were used. A register of the minimum temperature was also kept, with notes as to the depth of snow, copies of which are subjoined.

The extreme depth and softness of the snow, together with the many heavy storms experienced, prevented any great progress being made; on several days, after working hard from daylight till dark, we could not accomplish ten miles. An abstract is given of the distances travelled and the time occupied; over 900 miles being on snow-shoes, for the last 300 of which each carried his pack. My Indians at times became much disheartened, but behaved well throughout.

We fortunately escaped accident or sickness of any kind, except the unfailing attendants on hard travel in winter—snow-blindness and "*mal de raquette;*" and I am glad to be able to report the successful completion of the most hazardous expedition I have ever taken part in.

In conclusion, I must mention the generous hospitality and ready assistance I invariably received from the officers of the Hudson's Bay Company, to many of whom I was personally unknown; and I must give a word of praise to the pluck and endurance of my assistant, C. F. Hanington. A statement of the expenditure incurred will be sent you in a few days, together with such vouchers as I have been able to obtain.

I have further in preparation an account of the exploration written in more extended narrative form which will shortly be forwarded to you.

I am, Sir,

Your obedient servant,

E. W. JARVIS,

Engineer in charge of Expedition.

SANDFORD FLEMING, Esq.,

Chief Engineer.

Exploration of Smoky River Pass, 1874-5.

TABLE OF DISTANCES.

From Quesnelle Mouth, B.C.	Actual Days' Travel.	Snow-shoes.		Horses.		
		With Dogs.	With Packs.	Flat Sleds.	Packs.	Carts.
To Fort George	10	135				
Forks on North Fraser	7	98				
Salmon Cache and return	6	90				
Head of North Branch and return	13½	100				
Entrance to Pass	6	48½				
Summit	4	34½				
Smoky River Cache	8	87				
Fiddle River Depôt	11		108			
Jasper House and return	1		14			
Lake St. Anne	13		217			
Edmonton	2			50		
Victoria	4			80		
Pitt	6½				122	
Carlton	8½					167
Ellice	10					316
Winnipeg	5½					220
Total	116	593	339	130	122	703

Days	116
Miles	1,887
Average per day, miles	16·26

Minimum Temperature from 1st January to 6th April, 1875, registered by Mr. Jarvis in the course of his Journey across the Rocky Mountains.

	°		°		°		°
January 1	—32	January 25	14	February 18	32	March 14	—32
do 2	—26	do 26	— 2	do 19	28	do 15	—30
do 3	—40	do 27	—23	do 20	25	do 16	—23
do 4	—10	do 28	—29	do 21	29	do 17	—20
do 5	—38	do 29	—10	do 22	25	do 18	— 8
do 6	—28	do 30	14	do 23	11	do 19	—12
do 7	—36	do 31	— 2	do 24	— 2	do 20	9
do 8	—47	February 1	—23	do 25	—15	do 21	6
do 9	—25	do 2	—29	do 26	— 2	do 22	— 3
do 10	—45	do 3	—10	do 27	—10	do 23	—12
do 11	—31	do 4	7	do 28	8	do 24	— 9
do 12	—40	do 5	— 8	March 1	— 6	do 25	4
do 13	—50	do 6	2	do 2	12	do 26	— 6
do 14	—53	do 7	4	do 3	—11	do 27	5
do 15	—48	do 8	8	do 4	— 8	do 28	— 4
do 16	—36	do 9	24	do 5	—15	do 29	15
do 17	—41	do 10	—22	do 6	— 5	do 30	5
do 18	—45	do 11	8	do 7	22	do 31	9
do 19	—45	do 12	12	do 8	15	April 1	23
do 20	—31	do 13	2	do 9	5	do 2	24
do 21	3	do 14	3	do 10	26	do 3	4
do 22	7	do 15	25	do 11	27	do 4	— 4
do 23	—10	do 16	15	do 12	15	do 5	6
do 24	8	do 17	27	do 13	— 2	do 6	8

Narrative of the exploration from Fort George, across the Rocky Mountains, by Smoky River Pass to Manitoba, referred to in the preceding report.*

*   *   *   *   "The weather at the beginning of January set in very cold, and we redoubled our exertions to get everything ready for a final start; the snow-shoes and sleds were being made in the Fort, but with the usual dilatoriness of Indians, who could not be made to understand the fact of any one being "in a hurry," they were already beyond the promised time of completion. Dense masses of vapor covered the river every morning, and we were pleased to see the ice stretching out from the shore on each side, and gradually setting fast all over. The thermometer all this week was down among the forties, and one morning at 6 a.m., it marked fifty three dregrees below zero. Alec's return was now anxiously expected, as he was overdue some three or four days; and knowing him to be punctual we could not but fear some accident had befallen him. Every time the dogs barked some one would run to the door, being sure the wanderer had returned; but only to be as often disappointed. One morning about dawn, a dog scratched at the door—surely Alec is coming!—But it turned out to be only poor "Jack" with one leg frozen stiff. The dog, as we learned from the Indian who liberated him, had strayed back on the trail we came by and was caught in a steel trap, where he must have spent a week of intense suffering. We bathed the foot in ice and water and succeeded in getting the frost out of it, but a short time after, it mortified and the lower joint had to be amputated; the dog soon recovered, and though useless as a train dog, Mr. B. kindly promised to give him shelter for the winter. I became very anxious about Alec, as well as chafing at the delay which was losing the best part of the winter; and an Indian was despatched to follow the river to Quesnelle and to return by the trail, on one of which roads he was sure to find some traces of the missing party. But the following evening, just at dark, as we were sitting round the fire, a ghost-like figure suddenly and silently appeared among us; and, the first amazement over, we gladly welcomed Alec back to the land of the living. The poor fellow was covered with ice from head to foot, and had a most spectral appearance. As soon as he was thawed out—thermometer forty-nine below zero—he told the following story: They made a good run to Quesnelle, arriving there Christmas Day, and started two days after to return by the river. There was, however, no appearance of ice at Quesnelle, so they put the dogs and load in a canoe, and taking another Indian to return with the canoe, poled their way slowly up to the Cottonwood canyon. Above this there was every appearance of good going; the river was frozen over, and the canoe accordingly sent back to Quesnelle. But after a few miles up the river, the ice was found to be overflowed, and had to be abandoned for the woods on the bank; and then their troubles began. At most five miles a day could be made through the dense underbrush, and even then the process of "doubling up" had to be adopted. Occasionally they would try the river again, but as this generally resulted in one or both getting an involuntary bath, it had to be given up. Their provisions also ran short; but, falling in with Indians at the mouth of Blackwater River, Alec obtained some salmon, and the services of one of the men to help him along. And finally, knowing how anxious I would be, he started ahead of the train from the Fort George canyon and arrived in the

* In the autumn of 1874, Mr. Jarvis was selected to make a winter exploration of the Smoky River Pass, with Mr. C. F. Hanington as assistant, and Alec Macdonald, who was engaged to take charge of the dog-trains. As this was the only means of conveying supplies it was necessary to limit the number of the party, and also to dispense with all unnecessary impedimenta.

The outfit therefore consisted of a pair of snow-shoes, a pair of blankets, and some spare moccasins for each man; while a piece of light cotton sheeting was taken to make a *tente d'abri*, the ordinary canvas tent being too cumbersome.

The supplies consisted of dried salmon for the dogs, and bacon, beans, flour and tea for the men; and were calculated to last two months.

In December the party pushed forward to Fort George, and there procured four dog trains with four Indian drivers, making a total strength (including those brought from Quesnelle) of twenty-five dogs and eight men. At the beginning of January the party awaited the freezing over of the Fraser, and Alec's return from Quesnelle (where he had been sent for more supplies.)

At this point the narrative begins.

manner above related. The following day the Indians and dogs arrived; and piling everything on the sleds they could possibly hold, we made all final preparations for our long tramp. The dogs from Stuart's Lake had not yet turned up; but as they could not be more than four or five days distant, it was decided to push on, and wait for them at the cache made in the fall. The Hudson's Bay Co's accounts being put into shape and certified for payment, we bade adieu to our kind host, and turned our faces northward.

The party now consisted of three white men, three Indians, and three trains of dogs, and the order of march was as follows: two men in front to "break track" or beat down the snow with their snowshoes to make a road over which the dogs could travel; then the three trains, with a man driving each—the lightest being placed first—and, lastly, Hanington or myself alternately bringing up the rear and making what is called a "track survey" of the route travelled. The bearings were taken with a pocket compass, and the distance measured by pacing, forty paces to the chain being found a good average on level ground or ice, and this was continued the whole of the distance to Lake St. Anne, fifty miles above Fort Edmonton. The intense cold continued until the third week in January, and camping out under these circumstances had its drawbacks. Many were the frozen noses and ears during the day's march, but, then, the exercise helped to keep us warm; while in the camp at night the largest and most roaring of fires scarcely did more than burn the side turned towards it, the other being made thus more susceptible to the cold. One curious effect of the extreme lowness of the temperature was to cause the fire to steam rather than smoke, and this with the very driest wood that could be found. The cold was also not without its effect on our four-footed companions; they frequently had frozen toes, and we were obliged to make moccasins of flannel and leather to protect their feet. One old dog, the leader of the Cariboo train, suffered a great deal from frost-bite, and on the third day out he was noticed to be very lame all the morning. A halt was called at noon to drink a cup of tea, and "Marquis" lay down with the rest, but when a start was made the poor dog made a feeble effort to rise, gave one spasmodic wag of his tail and rolled over dead. His legs were frozen stiff to the shoulder; the minimum thermometer, exposed to the sun on top of the sled at the same time, registered forty-six below zero. A hole in the snow on the bank was the only grave we could make for him, and a spare dog being harnessed in his place the expedition pushed on, not without sincere regret at our loss. The travelling was good on the main river, there being only four or five inches of snow on the new and smooth ice, and we made pretty long marches, but the snow began to get deeper when we turned up the north branch of the Fraser, at the head of which it was hoped that a pass through the mountains would be found. Six days after leaving Fort George, the cache was reached, and found not to have been disturbed either by Indians or wild beasts. Here the sleds were unloaded, and Hanington, with two trains and two Indians, went back to the main river, thence to go to Bear River, where one of the Indians had a salmon cache, and to bring two sled loads of dried fish—about six hundred—back with him. Alec and I, with the other train, went forward up the north branch to explore and break track; and six days later the whole party reunited at the cache, less the one Fort George Indian, who, having handed over the salmon, had returned overland to his village. A heavy fall of snow during two days rendered the return journey tedious, and Hanington had to adopt the old plan of doubling up. The snow falls soft and moist here, and has a wonderful faculty of adhering to the sleds, as well as piling up under the bows, making killing work for the dogs.

The following day the trains, three in number, furnished by the Hudson's Bay Company, made their appearance with good loads of fish, and a most acceptable package of moccasins. The full strength of the party was now six trains (or twenty-four dogs) and eight men, part of whom only were intended to go all the way, there not being enough supplies to take them all through; some were, therefore, to be sent back when the summit was reached. A whole day was spent in loading up and "lashing" the sleds, repairing harness, moccasins, &c., and it was dark before all was

ready. A small amount of provisions for dogs and men was left at the cache for those who were to return this way to Fort George. From our camp, which was on an island at the foot of the first canyon, we distinctly heard the sound of chopping on the opposite bank just as we were turning in, but no one could be persuaded away from the warm camp to solve any such mystery as this; although every one agreed there was something strange about it, no tracks having been seen; and if it were Indians, they would have been round our fire ere this. Yet there were the distinct and separate blows of the axe, and the crash of the falling tree on the river bank not two hundred yards from us, and the most careful search the following morning failed to show that any such thing had taken place. So much for the power of imagination. The great cold of last week had abated since the snow storm, and we managed to keep very snug in camp and warm at night by sleeping two together, and pretty close at that.

An early start was ordered and an early start was made, for we all saw clearly that no time must be wasted if we were to get over an unknown and apparently an unlimited distance, on a known and very limited supply of provisions. All my work of road making was useless, the heavy snow having sunk the ice and covered it with slush, completely obliterating the old track. We had to put four men ahead to make the road, the other four driving the six trains, and even then the progress was very slow. Just before noon one day Alec went to the bank where a small rill was dripping over a rock, for a drink, when he suddenly disappeared, the ice having given way and the water being deep at the foot of the rock. Johnny, however, was quick enough to make a grab at his head as he re-appeared, and beyond the wetting no damage was done. In the course of the few succeeding days nearly every one had a similar experience, though not such a complete ducking; on one occasion I went through only as far as the waist, catching the ice on both sides with my hands, but the current caught the snow shoes, and, turning them upside down, held them as in a vice, and the united efforts of all were required to extricate me. Hanington, being longer of limb, generally escaped by throwing himself flat on his face, when his body would land sufficiently far from the hole to be on sound ice; but the ice soon set firmer, and unless in the vicinity of open water was always safe.

The valley of the river we were following was about a mile wide, and running directly south-east as far as the eye could reach; on both sides were high rocky peaks covered with perpetual snow, those on the right bank being spurs of the main chain of the Rocky Mountains along whose base we were travelling. There were apparently no obstructions to an easy passage within sight, but we were sadly deceived, for less than fifty miles from the cache we found ourselves at the bottom of a one hundred foot fall, with thickly timbered hills six hundred feet high on each side of it: these rising abruptly from the water's edge seemed to offer no footing for a snow shoe, much less a practicable trail for a dog-sled; but after half a day's careful exploration the only practicable plan was adopted and a regular track graded round the face of the bluffs. The great depth of the snow was serviceable to us here, for with snow shoes as shovels, and poles and brush to make bridges across the intervening gullies, a path four feet wide was soon made to the head of the first fall. But we were by no means through the canyon yet; for a mile more the river was confined between perpendicular walls of rock up which there was no climbing, and we had to seize on every "coign of vantage," narrow ledges of rock, banks of ice and snow clinging to the edge, bridges from one huge boulder to another; with the dark water boiling and foaming at our feet, ready to engulf anyone who made a false step. But the good ice was reached at last, and the party pushed on, well pleased at having surmounted so formidable an obstacle. Our joy, however, was of short duration, for once fairly launched in the mountain range canyon succeeded canyon, and the bed of the river became so full of boulders that progress was reduced to a minimum. About this time too (the beginning of February), the weather was very stormy and the falls of snow were frequent; the snow-shoeing become very laborious, and everyone's spirits depressed in consequence. Several moose showed themselves on the river, but neither the time nor the inclination for hunting (and perhaps the lack of necessity) induced us to go after them, so they were allowed to trot off in peace.

Great numbers of ptarmigan passed over our heads in some of the canyons, but as the shot-gun had long ago been voted a nuisance and left at Fort George, they approached with impunity.

So great was the depth of snow here, that several times when standing on the blankets in camp (the snow having been shovelled out down to the moss) we could not see over the edge of the hole in which we were; and the wood pile was frequently overhead. But on the river itself the depth did not exceed two feet or two feet and a half; into this, however, the snow-shoe would sink a good foot, and coming up with a small avalanche on the toe at each step, caused many blisters and occasional *mal de raquette.*

The valley soon took a sharp turn to the north-east and entered the main range, while the river decreased in size, dwindling down to a mere creek tumbling down the mountain side. Here we left the dogs, and Hanington and I, with a couple of men each, did what climbing we could to discover the source of the river, each taking a different branch. But they both terminated in the same way, a small muskeg or swamp, of a semicircular form, surrounded on three sides by high bare rocky peaks, between which the long, clear blue line of the glaciers was painfully apparent. A return to camp was all that could be done—evidently no pass this way—and a long discussion over many pipes did not much help matters. As Hanington said: "We "seem to have got to the back of the north wind," and I reluctantly gave up the idea of any more exploration in that direction. We were certainly in the heart of the mountains and would no doubt have admired the magnificent scenery under any other circumstances (out of the window of a Pullman car, for instance) but the feeling of disappointment was too strong just now; scarcely even allowing us to take notice of the gambols of the "Bighorns" a thousand feet above us, who could be discerned through the field-glass taking stock of the intruders, and strutting up and down with a challenge, as it were, to scale the glacier and meet them on their own ground. There yet remained a possibility of getting through by a more southerly pass, and this might be reached by going up the south fork of the river, the mouth of which we passed a few miles above the cache. The sleds were accordingly loaded up, and we returned down river to the "Forks" where we camped on the 12th February. Here we rested a day; and as the number of the party might now be reduced, there being a smaller amount of supplies to carry, two of the Indians and two of the hired trains were sent back to Fort George. Both dogs and men felt the good of a day's rest, after a month of incessant hard work.

The returning party carried with them our best wishes, and a letter to the Chief at Ottawa, explaining the position and announcing my determination to make another attempt to find the Smoky River Pass, by following up the south fork of the north branch of the Fraser River. A small hand-sled having been made (by cutting down one of the large ones) three men started off with their blankets and a week's provision on it, the other three to follow a day later with their dog-trains. By this means it was hoped that a good track might be secured, and the work be made easier for the dogs; the trains, owing to the reduced number, being now loaded as heavily as at the start; and although the plan worked well for a week, the mild weather and almost total absence of frost at night, caused it to be abandoned at the end of that time.

Scarcely had we lost sight of our camp at the "Forks" when we came to a more mighty canyon than any yet encountered, which necessitated a detour of about three miles overland to avoid it. In attempting at first to get through the canyon and thus avoid a portage through the woods we went over some very doubtful places, at one of which the rocks were overhanging to such a degree that Hanington had to take off his snowshoes (he going first) and creep along a ledge on hands and knees for fifty yards, while just beyond this, a fall (not very lucidly described by an Indian as being "high all-the-same one stick") put a stop to any chance of getting through the canon. Returning along the ledge, part of the snow slid away, but Hanington successfully imitated a limpet, clinging to the rock until a pole was held out to support him past this somewhat dangerous spot. In grasping the pole,

however, he let go one of his snowshoes, which whirled away down stream and was given up for lost, when a sudden turn of the eddy brought it to the surface near enough to be fished out with the pole. At the south end of the portage the descent to the river was very steep, and with only one driver to each train, their downward course could not be confined to ordinary speed. The usual method of "putting on the brakes" by turning the sled on its side, and sitting on the curved bow was of no avail here, for in attempting it I was hurled to one side, and the whole train went pell-mell to the river, fortunately without doing any more harm than the breaking of a few traces. But Hanington devised a cunning plan, and "anchoring" his sled by the tail-rope to a tree was enabled to lower it gently for a short distance. When, however, he let go to change the rope from one tree to another, it became unmanageable and the whole concern started on its downward career, promising a repetition of my descent; but scarcely had the sled got abreast of the dogs when it sheered off to one side of a small sapling, they running or rather rolling on the other. The sapling bent, and the impetus carried the whole train out on it about 20 ft., the dogs hanging by their traces and just counterbalancing the sled, and swaying up and down in most ludicrous plight. A few blows with the axe set them free, and the river was reached without further mishap. The water had overflowed the ice in many places above the canyon, and this impeded our progress very much, as the bottom of the sleds had to be scraped every half mile to get rid of the slush sticking to them, which would soon have turned to ice. The sight of one small bit of clear, glare ice was hailed with a shout; even the dogs seemed to enter into our feelings, and set off at a scamper to cross it. But it was like a mirage in the desert, only meant to deceive, for no sooner did the weight of the sled come on it, than in it went, dogs and all—the ice proving to be no more than a quarter of an inch thick, and probably only frozen the night before. The water, however, was only a couple of feet deep, so they were easily fished out again. On the banks we saw several marks of old chopping, and at one camp found a very old axe, like those made years ago by the blacksmith at York Factory, on Hudson's Bay. This was cheering to the whole party, as it seemed to prove that we were on the right road to the desired pass. Old Indian stories tell of the time when the Crees used to cross the mountains here, and even bring horses as far down as the first big canyon.

The valley of this branch is very similar to the one first followed; and at about the same distance from the Forks it also turned off to the north-east, and we entered the Rockies again. Here there was a great deal of open water, caused probably by the extreme mildness of the weather for the last few days. There occurred here one of the most sudden changes we ever experienced; going to bed one night with all our available clothing on, and the thermometer at forty-two degrees below zero, we were awoke next morning by the pattering rain on our faces, and found the temperature had risen to forty—a change of eighty-two degrees within eight hours. We were enervated by this, as it appeared to us, sultry heat, and the dogs went along panting, with outstretched tongues. Our snow-shoes also gave way, being thoroughly water-logged, and half a day had to be devoted to repairing damages. During this afternoon, Alec noticed one of his dogs, a fine bull-pup named "Captain," wandering about in an unsettled way, but he finally brought himself to anchor on top of the wood-pile (turning round twice as all dogs do before lying down, because, I suppose, "one good turn deserves another") a post that he ever after successfully held against all comers; and he even went the length of plainly intimating that he desired to be fed in no other place than that. As "Captain" was a great favourite, his very reasonable request was acceded to, though not without sundry pitched battles between himself and the Husky (or Esquimaux) dogs, who seemed to object to any partiality.

The entrance to the Pass is very grand, being guarded on either side by high pyramidical peaks towering two to three thousand feet above the valley and covered with perpetual snow. To the most prominent of these points we gave the name of "Mount Ida," and it was here we saw one of the most magnificent of the many fine glaciers along the route; it could not have been less than a mile long, and five

hundred feet thick at the face; while it was of such a transparent blue that we could almost imagine seeing the rocks underneath and through it. Just when I had chosen a place to camp, a roll as of distant thunder was heard, and a mighty avalanche seen rolling down the mountain side just above us, the masses of ice and rock chasing one another and leaping from point to point as if playing some weird, gigantic game. While we were discussing the probability of its reaching us—which however was strenuously negatived—down came one huge boulder as though making directly for us; but being turned aside by the trees as it crashed through them, plunged into the river a chain in front of the dogs, who appeared puzzled to account for its sudden arrival. It was of limestone and about ten feet in diameter. We did not camp near that spot.

The next day the stream began to rise rapidly and become much smaller, a good deal of open water drove us from the ice into the woods; and finally a sudden termination of the valley and the usual small stream trickling down the mountain side, showed conclusively that no practicable pass existed here. But the weather was fine, cold and exhilarating—and I decided to push on to the summit, if there were such a thing possible. Abandoning the creek, we climbed a couple of thousand feet to a lake whose dimensions were shrouded in mist—all we could tell about it was that it is the head of one branch of the river we have followed up. Leaving the camp near the lake, Hanington and I went ahead four or five miles, and passing through as many lakes nearly all at the same elevation, hailed with joy the appearance of water running to the east, and returned to camp to tell the welcome news; at the same time making known my intention of pushing on towards Edmonton, rather than to turn back after having gone so far towards it. Everyone being anxious to see "the other side" we were off at grey dawn and well across the large lake before the rising sun gave a splendid view of the surrounding country. The Lakes lie in a long deep gorge running due east and west through the mountains, about a mile wide, and perfectly straight for seven or eight miles. Having discovered the exact spot at which the waters divide, several trees were blazed, and having marked one of them in a conspicuous position, as the "Boundary between British Columbia and the Nor'-West Territory," with our names and the date, we started "Eastward ho!" with more satisfaction than we had felt for many a day. At the little stream issuing from the east end of the lakes we took our first drink of water flowing to the Arctic Ocean, and supposing we were at the head of Smoky River, we christened the peak which guards this end of the pass, "Smoky Peak." The stream soon became large enough to travel on, and with such an evident down grade as to call forth allusions to *facilis descensus Averni;* and by inverse ratio, the lower we got the more our spirits rose. The most curiously noticeable fact was the rapid increase in the size of the river, which, at the end of the first day's travel on it, was already a couple of chains wide, and this without the visible addition of any branches which would help to swell the volume of its waters. Early the second morning, we met with a check; Hanington and I were ahead when, on turning a sharp bend in the river, an immense abyss yawned before us, and we stood on the very edge of a fall which proved to be two hundred and ten feet high, and over which, had the morning been at all misty, we would probably have walked. There was no sound of falling water to give warning of the dangerous proximity; and it afterwards appeared, when looking up from below, that the whole party had been standing on what was merely a projecting cake of ice and snow, not more than a couple of feet thick The left bank appeared most favorable to make a portage* on, and we had to go back a short distance to climb the hill on that side. I took the first opportunity of descending again to the valley of the river, sitting as usual on the heels of my snowshoes, but taking some rather ugly and unforeseen jumps over sundry little bluffs near the bottom, and finally landing minus mitts and cap, full length in the open water, fortunately only about a foot deep. The others continued the portage farther, as it was impossible to descend near that point with the dogs; but they had

* The word "portage" is always used here to signify leaving the river, as in canoeing it applies to any place where it is necessary to carry the cargo, and sometimes the canoe itself, from one water to another.

eventually to come down a place very nearly as steep, where one of the sleds broke away from the driver, and coming in violent contact with a log in its downward career, made a sandwich of the unfortunate dog nearest the sled, and broke the "nose" (or turned-up bow) into a dozen pieces, besides damaging the harness. This was our first serious calamity, but, the dog excepted, everything was set straight in a couple of hours—the poor animal was past all care when the sled struck. A trivial incident like the death of a dog (and especially such mongrel curs as some of ours were) would not affect one seriously in a civilized community; but it cast quite a gloom over our little party, and even the dogs looked at one another, as who should say, "It may be my turn next!"

At the foot of this canyon we found ourselves fairly out of the mountain range; the few spurs that follow down each side of the valley are low and timbered to the summit (or rather *were*, for the whole country has been very recently burned over), and the bare rocky peaks were soon lost sight of behind us. The next day we saw marks of Indian chopping, and camps, apparently of last summer; and here, for a distance of twenty miles, we noticed the almost total absence of snow, a phenomenon said to occur all along the eastern base of the mountains. At one of our camps there was not more than two inches of snow anywhere in the vicinity. Our rate of travelling improved in consequence, and we made one big drive; but next day the old state of things returned, and the snow soon reached its average depth of two and a half feet, making the walking terribly heavy. This told on the dogs, who were getting tired out with their incessant hard work, and we had frequently to leave the sleds standing and the whole six go ahead to break track, then three return to bring on the trains, and still find the snow so soft, even after the passage of nine pairs of snowshoes, that the poor animals would wallow through it up to their bodies. It soon became evident this sort of thing could not last much longer; it was beginning to tell on the men as well as the dogs; and another cause for uneasiness suggested itself, "what if this be not Smoky River at all, but some other branch of Peace River, which will take us away, goodness knows where, if we follow it?" For we knew by our latitude, obtained by observation, and our approximate longitude, calculated by dead reckoning from the track survey we were making, that our course to strike the Athabasca River and the country we wished to explore between it and the Saskatchewan River would be about south-east, while we were now travelling at right angles to this course, or north-east. I could not, however, abandon the hope of the river shortly turning to the east, or even more in the desired direction, so we held on a few days longer. But scarcely a day passed when the dismal howl of the dogs did not announce to our unwilling ears that another of their number had dropped exhausted in his tracks; and it soon became very evident that we must put our best foot foremost in order to get through with safety to ourselves. At camp this night we saw a number of old Indian lodges, and marks of a horse-trail having been cut through the woods; this encouraged us to think we were on Smoky River, as Alec knew the Jasper Valley Indians had a trail by which they go in summer to it, but in winter we cannot find sure proof that it is a trail of pack animals. A long and earnest consultation, in which three different propositions were made: 1st, to assume we are on Smoky River, and to follow it to Peace River and Fort Dunvegan; 2nd, to go east to Fort Assiniboine, on the Athabasca; and 3rd, to go south-east to Jasper House, ended in the adoption of the latter; and the following day, finding the river turned still more to the north, orders were given to camp early, and a suitable place chosen to build a cache in which to leave everything that could possibly be spared. Going ahead a couple of miles to look for a good place to leave the river, we came across a very old and indistinct snowshoe track coming down on the river and after half a mile leaving it again, but without the least vestige of a track in the woods. This part of the country is evidently not much visited in winter; the scarcity of game would account for this, for we have seen absolutely nothing since leaving the mountains. We certainly expected to get deer or moose to eke out our stock of provisions, now becoming very small, but not a single one has been visible lately. Next day, the 5th March, we remained in camp to take a much needed rest,

and to make various repairs. I determined, if possible, to take one train to Jasper House, and Alec's was selected for that purpose; the other two sleds and their harness, together with superfluous clothing and instruments, were placed in a small log hut, six feet by four, and three feet high, built for the purpose, and the names and date marked on surrounding trees. Knowing the extreme difficulty of getting a loaded train through the woods, each one was to carry his blankets and share of the provisions, while the salmon were made into little packs and divided among the dogs, who would surely be able to get along with these small loads (not more than fifteen pounds apiece). The following day we started early, and by this must be understood a couple of hours before sunrise, our usual time for departure from camp being as soon as we could see to put one foot before the other, which necessitated rising at four o'clock every morning throughout the whole winter.

Going a couple of miles down the Smoky River we turned off to the south up a small creek, being anxious to keep as long as possible out of the woods; but so much time was lost in following its various turns and windings that we struck off to the south-east and pushed on, over hill and dale, regardless of anything but progress on the course laid down. We soon got into a terrible thicket of small black pine, growing so close together that we could scarcely force a passage through them; and at sun-set we laid down tired out and disgusted at having only made seven miles. Another couple of miles in the morning brought us to a river, the counterpart of the one we left, and which is probably its south branch. The high bluffs on the south side looked so forbidding that we went a couple of miles up the river, till we found a small creek coming in from the south-east, up which we turned. Looking for dry kindling wood in a drift pile of brush and trees at the mouth of this creek, Alec called our attention to what seemed a veritable saw-log, evidently cut by a white man (the Indians do not tackle anything over six inches diameter) and which must have drifted down from above. This puzzled us considerably. Was it possible we were on the Athabasca? Common sense said no; but then, how to account for the saw-log? If it be the Athabasca, then by keeping on our course we must soon strike the Macleod River; and the river we followed down from the mountains must be either Rivière à Baptiste or Old Man's River, and not the Smoky River as we thought. But we pushed on to the south-east, and only discussed these abstruse questions over the camp fire. The country was very broken, and consisted principally of long high ridges crossing our course at right angles, and covered with small pine of second growth. The frequent "ups and downs" were hard on the poor dogs, who were very weak, and fell exhausted daily; in order to spare them any more suffering, the stragglers received a *coup de grace* from one of our revolvers, and the others, "closing up" continued the march, only howling a requiem over their dead companions round the camp at night. From the top of one of the highest ridges, a perfect "Hog's back," we caught sight of a deep valley at our feet, and the Rockies fifty miles away to the south. This must be the Athabasca, and we hastened down, eager to reach a known point; but only to be disappointed, for it turned out to be a vast muskeg, nearly treeless, and from which we got a good look at the mountains away to the north-west, almost as far, we imagine, as "Smoky Peak." We must surely come to some water running the other way soon, which will be a sort of guide to us. Near camp to-night I found signs of a trail, a few trees having been blazed, but it did not appear to run in the right direction for us. Another high ridge loomed up in front, and surmounting it after much hard climbing, traces of the trail were again found, with old Indian camps and the head waters of a river running to the south-east. Surely we were now approaching the Athabasca! We plucked up heart and made a good day's march. But the blazes, at first easy to follow, become indistinct and finally lost before night, and when orders were given to camp Hanington and I started off in different directions to look for them, leaving Alec and the Indians to make the camp. On my return I found the Indians in a mournful state of despair, declaring they were lost and would never see their homes again, and weeping bitterly. It took a great deal of persuasion to set them on their legs again, and had there been any possibility of their running away there is but little doubt that their fears were so worked upon that they would soon have availed

themselves of it. But they knew their only chance of coming through in safety lay in remaining with the party, and they submitted to our arguments, though we found it somewhat difficult to use persuasive eloquence where we were not quite sure of the soundness of our own reasoning. The river, as usual, began to turn off to the north-east, so we decided to leave it and follow the old south-east course, which has so far led us into no great difficulties. The dogs decreased rapidly in number and size; a great favorite of mine, one of the Cariboo dogs, called "Buster"—probably a contraction of Filibuster—could not be coaxed away from the camp fire this morning, but no one had the heart to put an end to him, so he was left to his fate, not without many regrets By this time we expected to have been near the mountains seen some days ago, and possibly may have been but a thick mist shrouded everything for a couple of days and we groped along almost in darkness. But one bright morning the rising sun dispelled the mist, and from an elevated and burnt side hill on which we were travelling, Alec caught sight of a, to him, well-known feature in the landscape, the "Roche à Miette" whose peculiar and distinct profile was plainly visible about twenty-five miles south of us. This mountain is opposite Jasper House, at the eastern end of the Yellow Head Pass, and the sight of it was an immense relief to the minds of the leaders of the party, since it was from the Hudson's Bay Company's post there that we expected shelter and supplies, the latter having now reached very small proportions. The packs were thrown off in the snow, and we took a long rest and smoke—the feeling of security after the anxieties of the past month was too pleasant to be rudely disturbed, and even the stolid countenances of the Indians lighted up at the thought of a good feed and a respite from their incessant labours. But sitting on a log would not advance us much, so we marched off again, and getting on the ice of three or four small lakes made good time towards our goal. A bluff precipice intervening soon shut out our view, and to avoid it, we turned away to the left, crossing a high and heavily timbered hill, on the eastern slope of which we camped, with pleasant anticipations of returning to the land of the living on the morrow. But after supper Alec was seen stealing quietly away from camp, and being closely questioned on his return, admitted that he had gone to take another look at the "Roche" by moonlight, to assure himself that he was not mistaken. The bare possibility of such a thing alarmed us, and the evening did not pass as cheerfully as it begun. One thing was very evident, if that was not the Roche à Miette and the Athbasca in this hole at our feet, we might as well give up the hope of ever finding either, and the prospect was not inviting. But we slept well, nevertheless, for the clear bracing air, plain (not to say meagre) diet and constant hard exercise, ensure that.

About three miles from camp next morning we found ourselves on the benches overlooking the long-sought river, and it became a perfect scamper who should reach it first—*mal de raquette* was forgotten, (though it is generally a pretty attentive companion) and the half-starved dogs staggering along after us, joined in the enthusiasm with the most feeble of barks. But the effort was too much for them, and one more faithful servant dropped in his traces a few yards from the river bank. Ascending the river a couple of miles we came to the "Lac à Brûlé" where the ice was almost glare, the snow being blown off by the furious winds that rush down through the Pass like a funnel; and we travelled without snow-shoes the first time for three and a half months. The eight miles up this lake was soon got over, and arriving at the Fiddle River Depôt (built by Mr. Moberly) we were cordially received by the Iroquois Indians camped there. An immense dish of boiled rabbits set before us disappeared in quick order, and after this good meal we were more reconciled to hear the Company's post at Jasper House was abandoned. What was now to be done? We were at least ten days' journey from Lake St. Ann's, the nearest post we could depend upon, with only about two days' supplies remaining. The Indians could not give us anything, so we seemed to be in a tight place. But a long talk with an old squaw, who spoke very good French, ended in her promising to get everything that could be spared for us in the way of provisions, and the opportune display of a little money, raised the *auri sacra fames* to such a pitch that, early next morning by collecting from the various lodges round, we scraped together some sixty pounds

of dried deers' meat; and as there was no immediate prospect of starvation, a halt was ordered for the day. I and one of the Indians rode up to Jasper House, about seven miles by the trail, where a quarter of mutton (mountain sheep) had been cached. There was nothing at the store but a little powder and shot; so we returned to the Depôt, and the afternoon was spent in dividing the provisions into packs. The number of dogs was now reduced to seven, and as they were too weak to travel—besides not being able to spare them any food from our scanty supply—it was arranged that the Indians should take care of them until they could be turned over to the Company or some of our own people. Having bought some moccasins and rewarded our kind entertainers, we shouldered our packs and turned our faces towards Edmonton.

The wind blowing as usual directly down Lac à Brûlé was this time in our back, but the ice was so glare that we could not keep our feet; and after staggering and creeping along for half a mile, we had to put on our snow-shoes and skirt the shore. On the Athabasca the going was good, and we were not long in making the twenty-five miles, to the point where we intended to leave the river. Keeping to the north of the line run two years ago by Mr. Moberly, we marched nearly due east to the Macleod River; but our progress was very slow owing to the great depth and softness of the snow as well as the dense thickets and tangled brûlés we had to force our way through. We were fortunately not encumbered with dogs, or we would have spent still more time in choosing a passable road for them. From what is called the "Macleod Portage" the last view of the Rocky Mountains was obtained, and few among us were loath to turn our backs on the scene of toil. The view from the east end of the portage is very fine; a panorama of immense extent lay at our feet, and the horizon for a distance of fifty miles was bounded by the lofty crests and snowy peaks of the "backbone of the Continent" rendered more beautiful than ever by the rosy hues of the rising sun, and becoming more and more interesting to us as we left them in the distance, and shook the snow from off our feet against them. Shortly after going down on to the Macleod again, we met the Hudson's Bay Company's outfit going to Jasper House to trade with the Indians we saw there; and from them we were fortunate enough to get a little tea (ours being exhausted), and a few pounds of pemican to recruit our very scanty larder. But our pleasure at having their track to travel on and thus save our weary legs was dashed by learning them to be eleven days out from Lake St. Anne. A careful division of provisions that evening gave us four days more, or perhaps five, if we could manage with less than a pound a piece each day; and we did not like the thoughts of what we were to do during the other five or six days. But there was nothing for it but to push on and hope for the best, so we followed the track two days down the Macleod. Here it became completely snowed up and overflowed; besides which, I thought it a round about way to follow the river, with all its windings, so far; and accordingly struck off due east towards Dirt Lake, which we were fortunate enough to fall in with next evening.

A curious sensation of numbness now began to take hold of our limbs, with an unwillingness, or rather inability to push one snowshoe before the other after lifting it up; this gave us the appearance occasionally of "marking time" and would no doubt have been amusing to a well-fed bystander; but to us it was no laughing matter. Frequent cramps in the hands, caused probably by the pressure of the pack-straps on the shoulders, also added to our discomforts. A couple of rabbits opportunely appearing near camp gave us an apology for a breakfast; and the evening of the third day after, we reached the Hudson's Bay Company's post at Lake St. Anne. The intervening time was probably spent in a sort of mechanical progress, for nobody seemed to have any very distinct ideas, except on the subject of looseness in the region of the waistband. We were very kindly received by Mr. McGillivray, the officer in charge, who set us down at once to a good meal of white-fish and potatoes; and, after the manner of starving men in general, we ate a great deal more than was good for us. There never was a more welcome riddance of a burden than when we threw down our packs and took off our snow-shoes at Mr. McGillivray's door, for although the loads did not probably exceed thirty pounds each, they felt, on our weak shoulders,

like a hundred. The next day was given up to much needed repose; and there being a beaten road from here to Edmonton, I arranged with Mr. McG. to furnish a couple of horses and sleds to convey us there.

We made the fifty miles to Fort Edmonton in a day and a half, and were hospitably received there and entertained by Mr. Hardisty, the gentleman in charge of the district. But our four days' rest was not very enjoyable; we all suffered much from cramps in the limbs; and the sudden change from semi-starvation to a liberal diet brought on an attack of dysentry, and it was some days before we completely recovered our strength. As the two Indians belonging to Stewart's Lake have to return there in the spring, I made an arrangement with Mr. Hardisty to keep them at his Fort in the meantime, and to give them a pack-horse and provisions as soon as the snow goes, to return by way of Jasper House and Tête Jaune Cache. Some horses of Moberly's party having been left at the Fort, we obtained ten of them, and procuring flat-sleds, buffalo robes and some necessary additions to our wardrobe; and taking charge of a " Packet " or mail for Fort Garry, we started east, with Jack Norris as guide, on April 7th. Although our horses were very poor—as was the case with the stock both of the Company and the surrounding farmers, owing to the insufficiency of last years' hay crop, and the lateness of this spring—many horses and cattle having starved to death—we made the eighty miles to Victoria mission in four days. We were lucky enough to get a little barley and hay there; and, a very sudden thaw coming on, we remained with Mr. Adams, the gentleman in charge of the Company's post, for two days. The horses benefited by the rest and feed; and as we imagined the winter to be at its last gasp, and that the snow would soon leave us altogether, we concluded to exchange the flat-sleds for carts, to be obtained at Fort Pitt; using in the meantime the pack-saddles brought for this purpose from Edmonton. We accordingly started with five packs and five light (or unloaded) horses—and to avoid the snow in the woods near the Fort, followed down the Saskatchewan on the ice. But as this was knee-deep in water, we could not bear it after the first day; and climbed the bank again where we, with our snow-shoes, made much better progress over the drifts than the horses did through them. But the snow gradually got less and patches of bare ground appeared; being seized upon with avidity by the half-starved animals, glad to get a few blades of grass without " pawing " (digging away the snow with their hoofs) for them. We hung up our now useless and tattered snow-shoes on a tree, with suitable inscriptions. Water began to trouble us more than snow, for all the small creeks were breaking up, and invariably overflowed their banks. In some of them, the old ice (though under water) remained sound enough to carry us safely over; but in more than one instance—and notably at " Dog-rump Creek "—the whole valley, a quarter of a mile wide, was covered with a rushing torrent. Riding out to explore this waste of waters (up to the horse's shoulder on the flats) I suddenly plunged into the channel, but in spite of the shock of the icy water up to the neck,—the horse swimming low—was able to guide him across and effect a landing on the other side. The rest soon followed this involuntary example, and hauling the pack-horses across with a tow-line reached the east bank in a cool condition. A keen north wind soon coated us with ice, and as we had to go a couple of miles before finding any firewood, we were tolerably numb and shaky. The thaw, which we so confidently anticipated, came on but slowly; so that there was still a foot of snow when we reached Fort Pitt, six and a half days making the one hundred and twenty-two miles from Victoria. Mr. McKay kindly placed a room at our disposal, and fed us with his best. We here left our pack-saddles, taking in their place two carts. The ice on the Saskatchewan had broken up on the 18th, and the river, rising higher than usual, reached almost to the gates of the Fort. Wild fowl arrived daily; and, although the depth of snow seemed to render carting rather premature, the signs of spring were so many that it could not be long before it came. At the first hill we came to after leaving the Fort, our troubles began; for some of the horses had no idea of being in harness, and no amount of persuasion would bring them to collar—harshness and kindness were tried alike in vain, and for some days we had to change horses at every steep place.

The most incorrigible ones were subdued by the half-breed remedy of tying a rope from the shafts of the cart to the horse's tail, and by means of this novel tandem we generally succeeded in getting out of the worst places. But the drifts caused more delay than the hills; for the carts would generally run a little way out on to them and then settle quietly down to the axle; in many places we had to march up and down more than a hundred yards, jumping on the crust to break it and make three tracks, one for the horse and one for each wheel. The light animals were also driven through first to help break trail. After a few days, however, the "baulky" horses became knowing and refused altogether to venture into a drift unless unharnessed; so that we had several times to pull the carts through by hand ourselves. As most of the creeks were now quite open and very high, we rafted across them; not being in favour of any more swimming matches. The rafts used by all travellers on the plains are after one pattern; an oil-cloth or tent stretched over a framework made, according to circumstances, of willows, waggon-box or cart-wheels. The latter mode we adopted; laying two wheels side by side, overlapping till the rim of one touched the hub of the other, and lashing them firmly in this position. A tarpaulin was then spread on the ground, and the frame laid upon it, the ends and sides being turned up and tied to the rims. In this manner we were able to transport all our impedimenta across any stream where the tow-line would reach, in three or four trips. But winter seemed to have repented its departure, and returned in the shape of heavy frosts every night, which made our work of cutting through the drifts exceedingly labourious, and progress consequently slow. The crust became at last so solid that for forty miles above Carlton we drove our loaded carts on its surface; and instead of avoiding the drifts as heretofore, steered for the biggest of them, knowing they would best bear us up. In this fashion we reached Fort Carlton on the 29th April, having taken eight and a half days to come from Fort Pitt, a distance of one hundred and sixty-seven miles. The Fort stands on the south bank of the river, and when we came down the road on the north side, we could see little else but immense blocks of ice piled many feet high on either shore. After much shouting and gesticulation—the Fort being half a mile from us—we had the satisfaction of seeing a Mackinaw boat push out, and, skilfully avoiding the floating bergs, come to our side. Hanington and I took the packet, and, crossing over, were well received and entertained by Mr. Clarke, the officer in charge of the district. As it was now late in the day, the rest of the party camped on the other side.

The following morning, the horses were induced, after much persuasion, to trust themselves to the boat, and everything was safely crossed in two trips. We pitched our camp just outside the Fort, but Mr. Clarke insisted on our remaining in his house. The river broke up here a few days later than at Fort Pitt, and with more disastrous consequences. The water rose very suddenly and carried off the scow which was used as a ferry; and surprised some Indians, in the night, who were making maple sugar on an island twenty-five miles below; these poor wretches took to the trees, but as no help could reach them, dropped off exhausted one by one, till by daylight there were none left out of a band of a dozen. At Fort à la Corne, a hundred miles lower down the river, the water stood four feet deep in the Company's storehouse, and all the goods had to be moved upstairs, the people themselves taking refuge in the hills at the back. No news had been heard from Cumberland House, still farther down the river, and it was feared they might have suffered much, being situated in a low and flat region; but it afterwards appeared that this was the very cause of their safety, for the water, spreading over the surrounding country, lost the destructive effect it had when confined to a comparatively narrow channel, and passed harmlessly by.

For three days after our arrival, a keen north wind delayed the departure of the snow; but the beginning of May was warm and genial, and we prepared to take the road again. Some fresh horses were procured with great difficulty, and Alec brought some barley from Prince Albert's mission, fifty miles down the river; the country being reported burnt from here to Ellice, and feed consequently scarce. On the morning

of the 5th May we climbed the hill behind the Fort and set our faces towards the rising sun. The snow was nearly all gone, and we easily avoided the few remaining drifts. We reached the South Branch of the Saskatchewan the same afternoon, and spent four hours making two trips across with the scow, as a strong south-west wind (down river) necessitated the hauling of the scow a long way up on our side to ensure making a good landing on the other. At the French half-breed settlement here the people were driven out of their houses by the rising waters, which seem to have been higher this spring than for many years past. The grass having all been burnt off last autumn, gives the country a cheerless aspect; and we had to go to the margins of lakes or swamps to find any feed at all for the horses; but they, pushing on at the rate of thirty miles a day, with the characteristic endurance of Indian ponies, did not seem to feel the hardships of the trip as much as we had expected.

About forty-five miles from the South Branch we passed the "Spathanaw," or Round Hill, a conspicuous feature in the landscape; with a wooden crucifix on its summit, said to have been placed there by a worthy Bishop who spent Sunday at its foot. Not far from here, a road branches off to the south west, crossing the South Branch above where we did, and here we met with the first appearance of civilized usages—a finger post with the following inscription:—

Gabriel's crossing { Cart.........1s. 6d.
Waggon....2 0
Horses..... 6 }

Traverse de Gabriel Dumont.

ᐅᒪ ᒣᐤᑲᓈᐤ ᐯ" ᐅᓇᑫᐧ ᐁᐃᑕ ᒍᐧ

The latter statement was especially interesting; but we took it for granted that those for whom it is intended can make more out of it than we could; so we went our way and reached Touchwood Hill Post on the evening of the 9th. Here we left one of the hired horses, and as the others were already showing decided symptoms of "giving out" we had to continue the journey on foot, without even the occasional rest of a mile or two in the saddle, the animals having to be spared for use in the carts. But, wearing only moccasins, we found the unaccustomed exercise beginning to tell upon us at the end of a hundred miles, and by the time we had accomplished fifty more, were so footsore that we were quite ready to avail ourselves of a seat in a cart for half an hour when the half starved-horse seemed in a livelier mood than usual. A couple of days above Fort Ellice, we met two travellers, by name Livingstone and Fraser, footing their way towards the mountains, thence intending to strike for the Cariboo mines. They jogged along in primitive style, unencumbered by either blanket or provisions, carrying only a spare shirt, a gun and some ammunition. To save the necessity for a blanket, and also to avoid the heat, they slept by day and marched by night. On the evening of the 14th we camped at the mouth of the Qu'Appelle River, and crossed over to Fort Ellice early next morning; ten days making the three hundred and sixteen miles from Carlton. Here we received every kind of assistance from Mr. McDonald, the gentleman in charge; who, having no available horses of his own, endeavoured to replenish our scanty stock by hiring or purchasing for us from others. We made but a short halt, crossing the Assiniboine River on the scow after dinner—the bridge having been carried away by the freshet—and pushed on a dozen miles to the east over a very good road. In saying good-bye to Mr. McDonald, we parted with regret with the last of a number of gentlemen, officers of the Hon. Hudson's Bay Company, who have shown us every kindness and extended a ready hospitality on every occasion we have come in contact with them. To most, if not all of them, we were personally unknown; but it was sufficient to say we were in need of help, to ensure at once their best endeavours on our behalf.

We were delayed until ten o'clock next morning, as our horses had seen fit to

rejoin their companions near the Fort, but we got past Shoal Lake before camping time. In crossing the Little Saskatchewan River we had a good deal of trouble, the water was very swift and high, being above the horses' backs. The load had to be piled on an improvised rack on top of the cart body, and by an ingenious combination of tow lines, the horse swimming and the cart afloat, they were safely piloted across. This was our last excitement, except the breaking of an axle against a stump a few miles farther on, and we soon reached the flourishing settlement at the third, second and first crossings of the White Mud River, where the farmers were busy with their spring occupations, but not over-sanguine of success, owing to the annual scourge of grasshoppers, which has hitherto turned this fruitful colony into a barren waste

Passing Portage la Prairie on the 19th, we reached Winnipeg on the 21st May, having been five and a half months on our trip. At White Horse Plains we met a gay cavalcade going westward; it consisted of Mr. McLeod and his two survey parties, just starting for Edmonton and the Rocky Mountains, and their shining boots, glittering spurs and well-groomed horses contrasted with our battered and weather-worn appearance. But we could afford to suffer by the comparison; they would soon be as ragged as we were, and all their troubles were before them, while we were just reaching the goal, pushed forward to over many a weary mile of mountain and plain, and could take our well-earned repose in the happy consciousness of having fulfilled the task allotted to us, and earned the approbation of him we are proud to acknowledge our Chief.

APPENDIX I.

REPORT ON THE SURVEYS IN BRITISH COLUMBIA DURING THE YEAR 1875, BY MARCUS SMITH.

SIR,—After a full consideration of the plans, profiles and reports on the surveys and explorations in British Columbia up to the end of the year 1874, it was deemed necessary that further information should be obtained before deciding on the line for the construction of the railway, and the following surveys were projected for the year 1875:

1. A trial location survey from Waddington Harbour, at the head of Bute Inlet, to the neighbourhood of Fort George on the River Fraser, and it was understood that the location thence to the eastern slope of the Rocky Mountains, *viâ* the Valley of the Fraser and the Yellow Head Pass should remain in abeyance until Mr. Jarvis, then on his way across by the Smoky River Pass, should report.

2. A preliminary survey from a point on the above line, by the Blackwater and Salmon rivers to Kamsquot Bay on the Dean Inlet.

3. A preliminary survey from Kemano Bay, on the Gardner Inlet, across the Cascade Mountains to Lake François, and an exploration from the head of Gardner Inlet up the Valley of the Kitlope.

4. The location of the line on Vancouver Island from Esquimalt to Nanaimo.

To carry out this work, the Engineers for the formation of four survey parties were appointed in Ottawa. These arrived in Victoria on the 13th of May. Two other parties were then engaged on the preliminary survey of the line from Esquimalt to Nanaimo.

Before leaving Ottawa, I telegraphed Mr Robson, the Purveyor, to get ready four pack trains, and, with the least possible delay, to send them on with supplies and camp equipage to the several points required for the surveys.

I arrived in Victoria on the 13th of May, and found the four Divisions of Engineers completed and equipped for the location survey from Bute Inlet to the neighbourhood of Fort George.

Division N, with Mr. H. F. Bell in charge, left Victoria on the 18th of May and arrived at the Stewart River, about 15 miles from Fort George, on the 16th of June. They commenced their surveys next day.

Division R, Mr. W. T. Jennings in charge; and Division S, Mr. H. J. Cambie in charge, left Victoria together on the 18th of May, and arrived at the crossing of the Chilancoh River, about seven miles from the east end of Lake Tatla. They commenced their surveys at the same point, the former working eastward and the latter westward to the Pacific coast.

Division X, with Mr. C. H. Gamsby in charge, left Victoria on the 20th of May in the Dominion steamer " Sir James Douglas," and arrived at the head of Bute Inlet on the 23rd of May, where they commenced their survey up the Valley of the Homathco.

It was estimated that these four Divisions would complete the trial location survey from Bute Inlet to the neighbourhood of Fort George, about 300 miles, before winter set in.

The two Divisions, V and Y, completed the preliminary surveys of the line from Esquimalt to Nanaimo on the 25th of May.

With these two Divisions I proposed to make the preliminary surveys from the Dean Inlet up the valley of the Salmon River, across the divide, and down the Blackwater, where it would join the line from Bute Inlet.

Division Y, Mr. J. Hunter in charge, left Victoria on the 1st of May, travelling by the River Fraser and the Cariboo waggon road to the mouth of Quesnelle, where they met their pack train, with which they proceeded to the valley of the Blackwater, where they arrived on the 14th of June, and commenced the survey towards the Dean Inlet.

Division V, Mr. John Trutch in charge, left Victoria on the 1st of June, and on the steamer "Sir James Douglas." They touched at Waddington Harbour and landed stores for Division X. They also landed Mr. H. O. Tiedeman and Mr. C. Horetzky, with a small party of men to open the trail up the Homathco Valley, and Mr. Horetzky to take photographs of the canyons and other views of general interest. The steamer reached Kamsquot Bay in the Dean Inlet on the 5th of June, and landed Division V and their stores. They commenced the survey next day up the valley of the Salmon river.

Journey across the Cascade Mountains from the interior to Bute Inlet.

I left Victoria on the 11th of June in company with Mr. Robson, the Purveyor. We travelled by the Fraser River and the Cariboo waggon road to Soda Creek, where we arrived on the 19th of June, and my pack train arrived on the 22nd. Next day we crossed the Fraser and travelled on the trail leading to the Chilicotin Valley. On the second day Mr. Charles Seymour overtook us with eleven Lillooet Indians, whom we had engaged, and we travelled together.

* * * On the 29th June we arrived at the crossing of the Chilicotin River whence my pack train and the Indian proceeded westward to the Chilacoh Depôt and Mr. Seymour and myself rode on to Puntzee Lake, where we found Division R encamped. I spent two days with Mr. Jennings examining the rather broken and rough country on the divide between the Chilacoh and Chilicotin Rivers. About 15 miles of line had been located, which from the profile, appeared generally satisfactory. On the 3rd July we arrived at the camp of Division S, Mr. H. J. Cambie in charge. They had completed about 14 miles of location, and their trial line was some miles in advance on the east shore of Eagle Lake, which lies about five miles to the south of Lake Tatla in a trough in the side of the hill which bounds the latter. Eagle Lake is about six miles long, and a mile from its west end is the watershed, from which a rather broad valley descends nearly due south into the Cascade Mountains. In this valley there is a chain of small lakes which are the sources of the east branch of the Homathco River, which flows through these mountains into Bute Inlet. The last and largest of these lakes is Tatlayaco, which is 15 miles long and a little over a mile wide; it lies at the entrance of the pass, and the east branch of the Homathco River rushes out of it in a rapid current about 100 feet wide. It had been proposed to make the location survey by this route in the hope of finding a better line through the mountains than that surveyed in 1872 by Lake Tatla and the west branch of the Homathco River. The object of my journey was to examine this route in advance of the surveyors to ascertain if it had advantages that would warrant the survey being carried that way in preference to the line of the former survey.

We left Eagle Lake on the 5th July, and travelled on the east side of the valley, by an Indian trail; in the evening we encamped near an Indian Rancherie, on the margin of the small Lake Cochin, and the next day on the slope of the mountain that bounds the east side of Lake Tatlayaco. The view southward, from a point near our camp, was very grand; the silvery lake lay at our feet, several hundred feet beneath us; from its west bank rose a mountain of dark, jagged and scarred rock 3,000 to 5,000 feet above the level of the valley. On the left, near the foot of the lake a bold snow-clad mountain loomed up to a great height. These two form the portals of the entrance into the Homathco Pass. Beyond, the view was terminated by the lofty snow-clad peaks of the Cascade Mountains. From our camp, the trail curves up the slope by which the Indians reach the high table-land, which is well stocked with deer and mountain sheep, so that we had to cut a trail to the foot of the lake and had some difficulty in crossing a large glacial stream on our way. We arrived there on

the 7th July, and camped near the outlet of the lake, which is the east branch of the Homathco River. The distance to this point from the River Chilacoh, near which Division S commenced their surveys, a little over 40 miles. The first half of the distance is over a dry morrain formation, the surface broken with numerous dry ponds and lakelets, knolls, and gravel ridges, covered with stunted scrub pine, with patches of black spruce in low moist places. On the adjoining slopes, there is an abundance of Douglas fir of fair quality, and large enough for such bridging as would be required in the neighbourhood. The latter half of the distance is on the slopes of the valley by the margin of the string of lakes which feed the Homathco River. These slopes are broken by some deep lateral ravines, and the line will have to run across the faces of some rather steep rocky bluffs on the shore of Lake Tatlayaco. But, so far, this route appeared, on the whole, tolerably favorable for the line of railway, with plenty of timber suitable for works ot construction. We could not take the pack train beyond this point, so I sent it back to join the Y Division on the line from Blackwater to Dean Inlet.

By noon on the 8th July we had got our supplies and baggage rafted across the foot of the lake, and made a cache of provisions for use in case we failed to get through to the coast and were forced to return, or for the use of Tiedeman and Horetzky's party which we had expected to meet us here. We then commenced our tramp, my party consisting of five Lillooet Indian packers and one Chilicotin Indian hunter as guide.

About a mile below the mouth of Lake Tatlayaco, a large glacial stream comes in from the north-west. The weather had been very warm for a week past, and from the melting snow in the mountains, this stream was now very high, coming down with tremendous force, bringing trees and huge boulders from the mountain sides. Following this up a mile to where the stream is divided by a small islet, we succeeded in falling large trees across, by which we clambered over safely. Half a mile further down, a large stream comes in on the other side of the valley from the south-east. Here we are fairly in the mountains, and the valley is contracted almost to a canyon, there being only a narrow flat with a fringe of trees by the side of the river, which is in fact part of the old river bed silted up with detritus washed down by the stream. This flat is broken at intervals by rocky spurs shooting down from the mountains and abutting on the river. The course of the valley from this downwards turns to within a few points of due west, and is tolerably straight for about 20 miles, at which distance the view was terminated by an immense glacier, high up on the side of a mountain range which appeared to cross the line of the valley. There was no trail down this valley, as the Indians get to the coast by a way over the mountains farther south, so that our progress was very slow, being impeded by brush-wood, large trunks of fallen trees, and fragments of rock which had rolled down from the cliffs near the summit of the mountain. We travelled on the right bank of the river, which here flows between two well defined ranges. The slopes on the south side of that on which we were travelling were the more uniform and smooth; while the other side of the parallel range was rugged, perpendicular and broken. It took us two days and a half to reach the bend of the river about 15 miles from the foot of Lake Tatlayaco, where we camped on July 10th.

Down to this point there appeared no very serious engineering difficulties, the fall of the valley being tolerably uniform and estimated at the rate of about 1 per 100. But here the river takes a bend to the south-west, apparently cutting through several broken ranges of mountains, the noses of which at intervals abut on the Homathco River in perpendicular cliffs. The narrow flat belt by the river side has disappeared, except in small patches, and the valley has contracted to a narrow deep defile, but, as far as we could see, there was no canyon of perpendicular rocks on both sides of the river at once. Two days and a half more we toiled along the face of these rugged mountain slopes; the weather had become excessively warm, and from the unusual quantity of snow that had fallen the previous winter, the mountain streams were now roaring torrents which we had great difficulty in crossing; and at points where rocky spurs abut on the main river, leaving no passage between, we had

to climb up on hands and knees several hundred feet,—at one place 1,500 above the level of the river,—and descend again on the other side of the spur; such journeys sometimes occupying several hours, though the distance across the face of the cliff would not exceed a few hundred yards. But the mountain slopes are so steep and rocky that sometimes our Indian guide had to make a detour to reach safe footing, and then fasten a rope to a tree, throwing us the other end to assist us up with some degree of safety.

At noon on the 14th July we reached the junction of the east and west branches of the Homathco River. The last seven miles of our journey undoubtedly presented grave engineering difficulties. But however difficult we found it to travel, owing to the high floods and there being no trail, I had reason to think that a careful survey would probably show it to possess advantages over the line formerly surveyed by the west branch; therefore I thought it advisable to let the survey proceed by that route, and accordingly prepared topographical sketches and instructions for Mr. Cambie which I sent back by the Indian guide. I was much concerned at the non-appearance of the trail party under Mr. Tiedeman, which had been landed at Waddington Harbour on the 3rd June, whence four days canoeing should have brought them to within 12 miles of where we were now encamped, with the Waddington trail over half the distance. In two hours we succeeded in throwing a bridge over the canyon on the west branch of the Homathco and I sent some of my Indians ahead to make a reconnaisance and fire off rifles to attract the attention of the trail party, who, we supposed, could not be far off. In three hours they returned, reporting that they could not succeed in bridging the large stream that comes down from Tiedeman's glacier; they had thrown across it six of the largest trees they could find standing on its banks, which were whipped away by the torrent like so many chips. Our case was now becoming serious, we had but four or five days' supplies, left and feared that the trail party might have been detained by some difficulty with the Indians. We held a consultation to decide whether to go on or return, when our Indian guide said he could take us to the Waddington trail by making a detour of one day's journey up the bank of Tiedeman's River, and crossing the glacier out of which it issues. Accordingly, on the 15th July, we started at 6 a. m., and in two hours arrived at the glacier. We had some difficulty in ascending the face, which is an irregular slope covered with loose rock and boulders. It is about 200 feet high at the face, and, as far as we could see, was fully 15 miles in length, at the foot, and from half a mile, to three miles in breadth. The river rushes out of three tunnels, and the glacier is serrated lengthwise with ridges and crevasses; the latter partly filled up with boulders and detritus from the mountains. In fact, it has the appearance of having broken away in a body from the mountain bringing a portion of the latter with it. Its altitude is about 2,000 feet above the level of the sea. We succeeded in crossing safely by intricate windings on the broken surface to avoid open crevasses, in which we could hear the water gurgling beneath the boulders with which they were partially filled up. The sharp ridges were clear ice, along which we crept on hands and knees. Ascending the south-western slope of this glacial valley, we travelled the rest of the day on an elevated plateau, well timbered, and dotted with several small lakes. Towards evening we descended with difficulty by a lateral valley to that of the Homathco, where we found Mr. Tiedeman in charge of the trail party, encamped on the same spot where Mr. Waddington's men were murdered by the Indians in 1864. Since our survey of 1872 the Indians have removed all traces of the murdered men's camp, and burned the timber and brush which then grew there. Mr. Tiedeman had misunderstood the main object of his work, which, according to my written instructions, was to push forward as rapidly as possible to meet me, throwing log bridges across the larger streams while the water was low, and improving the trail on the return journey. Instead of doing this, he had made only a few miles of trail with trestle bridges six feet wide for pack animals. As the survey parties would not get into the mountains before the rivers were low, I desired Mr. Tiedeman to break up the trail party and join Division X to take the topography of the country.

On July 16th, we continued our tramp down the Homathco Valley, following

the Waddington trail; the weather continued excessively warm and the streams were still rising. On reaching the head of the Grand Canyon we found the river had carried away the bridge which Mr. Tiedeman had constructed round the face of the cliff, so we had to climb up by a crevasse in the rock, 400 feet, to reach the trail, which crosses over the shoulder of a mountain. In like manner we found all the bridges he had made carried away, so we had a repetition of climbing precipices and bridging torrents. We had expected to reach the camp of Division X in two days, but on Saturday evening we came to a torrent over which we could find no practicable means for throwing a bridge. So we had to camp, and, as we were out of meat. I sent the Indians out to hunt; they soon returned with a large black bear, thus relieving us of all apprehension on the score of provisions. Next day we commenced to construct an Indian fly bridge, but, as we had only one axe left and but little spare rope, we had to make lashings from the inner bark of cedar, so that it took us seven hours to complete the bridge, which, when finished, looked like a fishing rod and line hanging over the torrent, the butt end resting on the ground and loaded with boulders. We managed to crawl over this and drop down safely on the other side of the stream. Six hours more of a hard struggle among tangled creepers, over huge trunks of fallen trees and masses of detached rocks, brought us to the camp of Division X. This party had completed 13 miles of trial location. I remained with them two days, examined their plans and profiles; these showed the line to be generally satisfactory and a great improvement on the preliminary survey of 1872. On the 20th, we dropped down the river in a large canoe to Waddington Harbour, where the steamer "Sir James Douglas," arrived next morning. After discharging cargo the steamer started back for Victoria, arrived at Departure Bay and took in coal; on the 26th July we arrived at Victoria much bruised and shaken by one of the hardest journeys yet made on the surveys.

Meanwhile Mr. Jarvis and party, who left Fort George in December, 1874, to examine a route across the Rocky Mountains by the north branch of the Fraser River and the Smoky River Pass, had arrived at Winnipeg, and reported unfavourably of that route. It was therefore decided to make the trial location surveys from Fort George eastward *viâ* the Yellow Head Pass, and a party was formed in Ottawa, with Mr. George Keefer in charge, to execute a portion of this survey, commencing at the summit of the Yellow Head Pass, and working westward to Tête Jaune Cache, thence down the Fraser to meet another party working up.

Mr. Keefer and party reached Victoria on the 18th July, and before I arrived they were on their way to their appointed work, but I sent a messenger after them with detailed instructions for the practical carrying out of the surveys committed to their charge. The messenger overtook the party in the valley of the North Thompson, and Mr. Keefer has since advised me of their arrival in the Yellow Head Pass and the commencement of the surveys."

Journey from Dean Inlet across the Cascade Mountains by the Salmon River Pass.

I had estimated that the Divisions V and Y would connect their surveys on the Salmon River before the end of August. On the 23rd of that month, therefore, I left Victoria on the steamer "Sir James Douglas." We called at Waddington Harbour on Bute Inlet and landed supplies for the X Division, and on the 28th we arrived in Kamsquot Bay on the Dean Inlet, where we found Mr. Trutch and party (Division T,) encamped on the spit of land that forms the south side of the harbour. They had joined their surveys with those of Division Y a week before, about 50 miles up the Salmon River, and had then returned to the coast for instructions. I immediately had the party re-organized for the survey from Kemano Bay, on the Gardner Inlet across the Cascade Mountains, towards Lake François, sending some of the men home to Victoria and replacing them with Indian packers whom I had brought with me by the Homathco Pass. The steamer left with the party on the 1st September, and on the 3rd arrived at Kamsquot Bay, where the party disembarked to commence the surveys.

In my report of the work of 1874, Kamsquot Bay is described as being formed on one side by a tongue of land about two miles in length, projecting into the Dean Channel: the Kamsquot or Salmon River flowing into the channel on the other side of the tongue. This tongue has been formed by the debris brought down by the river, which has burst through a curtain or saddle of rock about 400 feet high, which stretches across the mouth of the valley. I engaged Indians to pack my baggage and supplies across the mountains, and on Monday, the 30th August, they had got everything to the head of the canyon through the saddle of rock about 2½ miles on the line of survey. Next morning, we all embarked in a large dug-out canoe, being eight persons in all, besides baggage and supplies. The stream varies from 150 to 300 feet in breadth; it is very rapid, and the canoe was forced up by poling. In some places the rapids were so bad that we had to get out, and the Indians, wading in the water, lifted the canoe up by hand. We made about 12 miles the first day, and at noon on the second day we were at the head of canoe navigation, near the 19th mile of the survey. The valley, up to this point, varies from a quarter to three quaters of a mile in breadth; the river, meandering through the valley, washes the base of the rocky slopes on either side; low alluvial flats, heavily timbered, intervening.

From the head of canoe navigation our supplies and baggage had to be packed by hand. We followed the trail made by the V Division under Mr. Trutch, which led alternately over flat benches, varying in height from 20 to 200 feet above the level of the river, and along the steep slopes of the hills which are in many places slides of loose rock. The superior ranges of snow-clad mountains are at a considerable distance from the river, but, in a few places, a spur shoots out and extends to the river, abutting on the same in a perpendicular rock-face, leaving no passage between. The heaviest of these is about the 31st mile of the survey, and the trail goes over the spur about 600 feet above the level of the river. On the second day from the head of canoe navigation, we reached Yeltesse, or the Salmon House, 34 miles from the sea on the line surveyed. Here the river rushes through a narrow rocky gorge, the lower ledge of rocks being about 20 feet above the level of the river, over which there is an Indian bridge or platform of round timbers. Immediately below this there is a fall of about 15 feet, over the face of which the Indians have constructed a screen of wythies, to which are hung pockets of network for catching salmon as they endeavour to leap the fall. The salmon, striking against the screen, fall into the pockets. The river is well named the Salmon River, as it swarms with that fish. On my way up, the Indians with the canoe poles speared what we required for food, some of the fish weighing over 30 lbs., and at the bridge they were constantly carrying away salmon that were caught in the nets. These are called "Stick Indians," or dwellers in the forest. They appear to be of the same race as the Chilcotins, certainly they intermarry with them and understand their language. They are mountaineers; not large in physique, but wirey, and have been of great assistance in packing for the surveying parties. At Yeltesse we are clear through the high ranges of the Cascade Mountains, and the river comes to this point in a deep groove in the central plateau, which is of volcanic formation, the rocks being mainly basalt. The survey followed the river for about 30 miles above this place, but the trail goes up a parallel valley to the south. In this there are saveral small lakes, the largest, Tanyabunket, being about six miles in length. This valley, at the lower end near Yeltesse, is about 1,000 feet above the level of the river; at the upper end, 30 miles distant, they are nearly of the same level, and there the trail leaves the valley and crosses the Salmon River to the north side at the point which we reached in our exploration of 1874.

On the 8th July, I started with my pack train eastward from Yeltesse, to examine the line of survey in the Salmon River valley and across the Divide to the Blackwater, thence down the same to its junction with the line from Bute Inlet. The whole of this portion of the line is in a depression of the central plateau, and presents no engineering difficulties till after its junction with the line from Bute Inlet. On the 18th September, we reached Mr. Bell's camp (Division N), on the Blackwater. About seven miles above this point the river is crossed by the telegraph trail. Mr. Bell and myself spent several days examining the rather rough country which forms

the watershed between the Blackwater and Chilacoh. We followed up the valley of the latter 20 miles above the point where the line of survey leaves it, and found that it widened as we ascended. A branch of the river, coming in from the west by a broad valley, appears to turn the north end of the range which divides it from the Blackwater, and gives facilities for a deviation of the line to Dean Inlet, by which much heavy work would probably be avoided.

On the 23rd September, we left Mr. Bell's second camp on the Blackwater, and proceeded on our homeward journey. We reached the confluence of the Blackwater and Nazco on the 25th, and, following up the valley of the latter about 20 miles, we arrived at the camp of Mr. Jennings (Division R.) on the 27th. Up to this point and several miles above it, the Nazco is a fine open valley; the river, 80 to 100 feet wide, winds through extensive natural meadows with groves of spruce, black fir and aspens at intervals. We travelled on the trail up the Nazco Valley to the lakes on the central plateau which form the sources of the river, then crossed to the Alexis Lakes and down to the Chilicotin Valley, which we followed nearly up to its junction with that of the Fraser, then up the latter to Soda Creek, which we reached on the 7th of October. I left my party at Soda Creek to take the train to winter quarters near Kamloops, and travelled by stage and steamboat to Victoria, where I arrived 16th October.

On the 15th October, the Divisions S and X, connected their surveys on the east branch of the Homathco Valley, on the line from Bute Inlet to the Yellow Head Pass, and returned to Victoria. On the 20th, the Divisions R and N, connected their surveys on the same line, near the mouth of the Nazco River. The former party returned to Victoria, and the latter went to Fort George to complete their plans and continue the surveys eastward during the winter.

The Division V, completed a trail survey of a line from the Kemano Bay on the Gardner Inlet, up the valley of the Kemano River and across the Cascade Mountains, to the first lake on their eastern slope, whence the waters fall into the Nechaco River, and returned to Victoria on the 21st October. About the end of the month, the Division M, under the charge of Mr. George Keefer, had to stop the location surveys from Yellow Head Pass westward, and they went into winter quarters at Tête Jaune Cache, for the purpose of making trial surveys, in advance of the location survey, during the winter, whenever the weather would permit.

The Divisions T and Y continued the location of the line on Vancouver's Island, between Esquimalt and Nanaimo, till the 9th of December when the weather had become so inclement that they could not work. They were within 8 miles of each other, so they connected their location surveys with the trial line previously run, and returned to Victoria.

The Channels around the Valdez Islands.

On the 29th October, I left Victoria in the Hudson's Bay Co's steamer "Otter," and next day arrived at Cape Mudge, where I engaged a canoe and a good crew of Indians, to make an examination of the several channels that separate the Valdez and a number of small islands that lie at the entrance to Bute Inlet. I spent ten days on this work; made a track survey of the channels that divide the Valdez Islands, to replace in some measure the plans of 1872 which had been destroyed by fire. We crossed the Arran Rapids, between Stewart Island and the mainland, when the tide was running very swiftly, then went up to the Estero Basin, of which I made a rough survey. This basin is at the head of the Frederick Arm, and the tide flows in and out through a channel about a third of a mile in length, and 50 to 150 feet in breadth. Between the head of the basin and Bute Inlet, there is a depression in the rocks across which it appears feasible to construct a railway; thence along the edge of the basin to the head of the Frederick Arm. From this point to a good landing on Vancouver's Island, the distance is about 16 miles, almost in a direct line by the Nodalles Channel, in which the highest rate of the tidal current does not exceed three knots per hour. The navigation to the ocean by the north end of Vancouver Island is also free from

dangerous rapids. After completing the survey of the basin, we descended the Frederick Arm and went up to the head of Phillip Arm, where a river 300 feet wide enters through an open valley. It had been reported by a person exploring for minerals, that there was a possible connection between this valley and the Homathco, but, from a careful examination of the west side of the latter, no depression could be found feasible for carrying a railway across. We returned home by the Nodalles Channel and Discovery Passage to Cape Mudge where we were detained two days by adverse winds coming up the Strait of Georgia. On the storm abating, we coasted down to Comox, where I took passage in the steamboat for Victoria.

This work was done in a canoe in the worst season for navigation, when, as we afterwards learned, the Pacific Coast was strewn with wrecks. We had fog and rain in abundance, and, by the scudding of the clouds, there was evidently storm without; but we had no difficulty in finding our way through rain and mist, and the wind did not affect us, so completely are these channels sheltered by the high land and rocks which they separate. I feel confident that a steamboat properly constructed could take a railway train on board and pass safely at all seasons of the year from any convenient point on Bute Inlet to a good landing on Vancouver's Island near Seymour Narrows. The only difficulty would be the swiftness of the current at a certain state of the tide; but the worst rapid could be avoided by using one of the cross channels that divide the Valdez Islands.

Character of the Line from Bute Inlet to River Stewart.

The Homathco Valley at the head of Bute Inlet is a mile and a half or two miles wide on the bottom flat which is bounded by precipitous mountain slopes. The general direction of the valley is north and south, and it decreases in breadth as we ascend, till about 30 miles from the Inlet, where the mountains close in and the river rushes through a narrow, rocky canyon or chasm. It is a turbid rapid stream about 300 feet in breadth, but at places it spreads out to over 1,000 feet, divided into several channels by low alluvial islets from the detritus brought down by the river. These islets are covered with spruce, poplar and heavy cedar trees. The river, in winding through the valley, alternately washes the base of the rocky slopes on either side, entering the Inlet on the west side. The located line commences about the centre of the valley on the high water line at the head of the Inlet, from which a pier of 2,400 feet in length would reach a depth of 24 feet of water at low tide. Around this point there is good anchorage.

The line takes a course nearly due north up the centre of the valley for a little over a mile, near to the foot of Mount Evans; it then curves away to the west, crossing the river—300 feet wide—near the second mile. Near the third mile it curves away back to a course nearly north which it follows to the 10th mile. Up to this point it is on a timbered flat nearly level and the work will be light, but here the river washes the foot of the mountains, and the line is carried on the face of the rugged slopes for four miles, where the river bends off to the other side of the valley, and the line is again on the flat land. The proportionate length of these alternate sections from the head of the Bute Inlet to the foot of the Great Canyon is 22 miles on flats with light works, 8 miles on the face of mountain slopes, requiring heavy rock cutting and four short tunnels, making altogether a length of about 1,200 feet of tunnelling. The cuttings, however, are short, through narrow rocky spurs, few of them exceeding 30 to 40 feet in depth at the centre, falling off rapidly to each end and latterally towards the river. The gradients in this section are generally easy, the largest being 58 feet per mile for half a mile in length, and the sharpest curves have a deflection of six degrees for chords 100 feet long, equal to a radius of 955 feet. The streams crossed on this section are: the Homathco River—300 feet wide,—six lateral glacial streams—20 to 100 feet wide. Some of these have brought down large quantities of debris from the mountains, raising their beds across the Homathco Valley considerably higher than the land a few hundred feet from each side of the stream. To avoid this difficulty, the line has been carried, in some instances, to the

foot of the mountain slopes, where the bed of the stream is lower than the adjoining land; in other cases the stream will have to be diverted. None of these streams are deep, but they are very rapid.

From the 30th to the 50th mile is through the heart of the Cascade Mountains and, with a few intervals, the river rushes through a continuous canyon. At the 39th mile is the junction of the east and west branches of the Homathco River. The survey of 1872 followed the west branch, which rises so rapidly for six miles that it was found necessary to go back to the 29th mile, and commence rising on the rugged rocky slopes, with a gradient of 100 feet per mile, which is continuous to the 44th mile with excessively heavy works. The present survey follows the east branch of the Homathco, but the trial line showed a rise of 775 feet on the first 6 miles. To ease this gradient, a line has been projected from the cross sections, which it is believed will give the best gradients obtainable, without greatly increasing the rock excavations. This throws us back to the 34th mile, between which and the 53rd mile, the profile, as shown by the dotted line, is only approximate; for when the trial line was completed and the new line projected, the season was then too far advanced to attempt the location.

The following are the gradients through the heart of the Cascade Mountains, commencing at the foot of the canyon near the 30th mile:—

2	miles	of 2.25	per	100—	60.72	feet per mile.
$2\frac{1}{4}$	"	" 1.10	"	"	58.08	" " "
$4\frac{1}{2}$	"	" 2.00	"	"	105.60	" " "
$\frac{1}{2}$	"	of level			0.00	" " "
6	"	" 2.00	"	"	105.60	" " "
$\frac{1}{4}$	"	of level			0.00	" " "
$1\frac{3}{4}$	"	" 1.40	"	"	74.00	" " "
$\frac{1}{4}$	"	" 0.85	"	"	44.88	" " "
$2\frac{1}{4}$	"	" 2.00	"	"	105.60	" " "
$\frac{1}{4}$	"	of level			0.00	" " "
20	"	Total rise			1,742	feet.

averaging 87.10 feet per mile.

There will be a large quantity of rock excavation throughout this section, including several short tunnels, but the reduction in heavy works is very considerable compared with the line surveyed in 1872, on which the average length of tunnelling in the Cascade Mountains was fully three miles; on the present line it will not exceed two miles.

From the 50th to the 61st mile at the foot of Lake Tatlayaco, the rise is 507 feet, being an average of 46 feet per mile. The highest gradients are one of 79 feet per mile for a mile and a half and another of 66 feet per mile for the same distance. None of the other exceed 1 per 100. The works on this section will be three miles heavy rock cutting and eight miles of light and medium work.

Near the 62nd mile, the line crosses the Homathco River—100 feet wide—close to its outflow from Lake Tatlayaco, which is 2,712 feet above the sea level, thence the line follows the eastern shore of the lake to its head at the 77th mile, with variable but generally easy gradients. Near the foot of the lake the works will be heavy for about a mile, consisting of rock cuttings and two tunnels, each 300 feet in length. Along the shore of the lake the cuttings will not be deep, but principally in rock. At the 65th mile the line crosses Cheshee River, a glacial stream 100 feet wide.

At the 77th mile, near the head of Lake Tatlayaco, we are fairly through the Cascade Mountains, and the line thence to the crossing to the River Fraser above Fort George, about 240 miles, traverses the Central Plateau, between the Cascade and Rocky Mountains, by some of the numerous valleys and lake basins with which it is indented.

Near the 94th mile is the summit which divides the waters flowing eastward to the Fraser and westward to the Pacific Ocean. It is 3,500 feet above the sea level, and the rise to it from Lake Tatlayaco is almost continuous, there being only a few short stretches of level intervening. The highest gradient is 1 per 100 continuously

for eight miles; the rest are easy. The works on this section will be moderate; the cuttings are principally in gravel and boulders, with a small proportion of rock. The heaviest works will be the crossing of the ravines, one of them 500 feet wide at the top and 114 feet deep, the other 400 feet wide and 113 feet deep. Both of them slope to only a few feet in breadth at the bottom.

From 95 to 101½ miles the line runs along the south-east shore of Eagle Lake with easy, undulating gradients. There will be a considerable quantity of rock cutting in this section. Hence to the Chilancoh Valley the line follows a depression in the plateau, apparently the ancient bed of the lake and river. The gradients are, except 1 per 100 for four miles, generally easy, descending to the Chilancoh, which is 2,975 feet above sea level where the line crosses the river which is 30 feet wide. This section is broken with ridges of sand, gravel and boulders, and small dry ponds. The works will not be heavy.

From the Chilancoh to the crossing of the Chilicotin River at the 139th mile the line is over a rolling country. From the 122nd to the 130th mile it passes on the north-west of Puntzee Lake, well up on the slope, in order to surmount the plateau between that and the Chilicotin Valley. The highest point is at 133 miles and is 3,467 feet above sea level. The rise is almost continuous from the Chilancoh to this point, but the highest gradient is 1 per 100 for a mile and a half. Hence, the line descends with easy gradient to the Chilicotin Valley; crossing the river—120 feet wide—near the foot of the Chisicut Lake at the altitude of 3,290 feet above sea level.

From the Chilicotin Valley—139 miles—the line reaches the highest point of the plateau at 153 miles, with easy undulating gradients. This point is 3,605 feet above sea level. Hence, to the west end of Lake Nestacho at 162 miles, the gradients are very easy, that point being 3,470 feet above sea level. The whole of this section from 139 to 162 miles is over an arid country of sand, gravel and boulders, and the work will be very light.

From 162 miles the line runs along the slopes of the valley by Lakes Nestacho Zazatee and Tchu-sin-il-til to 167¾ miles with easy gradients, but on half the distance there will be some rather heavy rock cutting: the balance will be light work.

From the last point—167¾ miles—the Nazco River, here only 20 feet wide, flows into a canyon, the head of which is 3,419 feet above sea level. The descent through the canyon, eight and a half miles in length, is at a uniform rate of 1 per 100. Half the distance is curvature, varying from 1,910 to 1,433 feet radius. The upper part of the canyon is composed of basaltic rock, the lower part conglomerate. There will be some heavy rock cuttings in this section.

From 176½ miles, at the foot of the canyon, the valley widens out so that between this point and the junction with the Blackwater, there is scope for more than one line. The line located has been chosen to shorten the distance as much as practicable, and to keep off the low lands which are subject to overflow, so that there are points at which it may be found desirable to make short deviations to reduce the quantity of rock excavation. The altitude at the foot of the canyon is 2,985 feet, and at the mouth of the Nazco 2,680 feet above sea level—a fall of 305 feet in 43 miles. The highest gradient 0.50 per 100. On some portions of this section there will be a considerable quantity of rock cutting, more especially on the shore of Lake Nazco from the 178th to the 182nd mile. The balance will be light work.

There are six crossings of the Nazco that will require bridges of one span of 100 feet, with about 50 feet of trestle bridging at each end, unless there are stone abutments. One bridge will have two spans of 100 feet each. The lower chords of these bridges will be only a few feet above flood level, sufficient to allow trees to float under freely.

From the mouth of the Nazco the line follows down the valley of the Blackwater 55 miles to the 234th mile, where the altitude is 2,537 feet, giving an average fall of 9½ feet per mile. But the gradients are undulating, and there are three sections of 1 per 100 making an aggregate of one and a half miles in length. About four miles of this section is on rock formation and the cuttings will be rather heavy. The balance is principally on gravel and boulders, probably resting on solid rock. The river is

very crooked in this part of the valley and the line crosses it three times, requiring one bridge of two spans of 100 feet each, and two bridges of three spans of 100 feet each.

From 234 to 237 miles the line ascends the slope of the valley obliquely on to the plateau, which divides the Blackwater from the Chilacoh Valley, with a gradient of 45 feet per mile. On this length there will be some heavy rock cutting and two tunnels, one 1,300 feet, the other 600 feet in length.

At 237 miles the altitude is 2,683 feet above sea level; thence the plateau is crossed in straight line with easy undulating gradients to 247 miles. The formation is sand and gravel, and the works on this section will be light. The height of the last point is 2,594 feet above sea level. Hence the line descends the slope by a serpentine course to the Chilacoh Valley, with gradients varying from 0.20 to 1 per 100. There are about four miles of the latter in several lengths with stretches of level between. The formation is sand, gravel and boulders, and there are no deep cuttings, but there are several deep ravines to be crossed. The largest of these is 500 feet at top, 10 feet at bottom and 110 feet deep.

At 256½ miles the line crosses the bottom flat of the Chilacoh Valley 2,400 feet wide, requiring an embankment or trestle work 30 feet high. The river is 120 feet wide. From this the line follows the Chilacoh Valley down to its junction with that of the Stewart at 289¾ miles. The gradients are very easy, the altitude at the Chilacoh being 2,225 feet and at the Stewart 2,055 feet. On the first twelve miles the works will be very light, but on the next five miles the river has cut through a range of hills and the valley is contracted; on this last section there will be some deep cuttings in sand and gravel.

The line at 273 miles is 2,120 feet above sea level, and thence to 286 miles the gradient is almost uniform at eight feet per mile. The works would be very light but for several diversions of the river, making an aggregate length of 4,000 feet. The cutting for these diversions will, however, not be deep. It is a sluggish stream rising to within a few feet of the level of the flat through which it winds. On the last three miles, to the junction with the Stewart Valley, there are some deep cuttings in sand and gravel and three short cuttings in rock.

Between the 257th and 289th mile the line crosses the Chilacoh River three times, and will require two bridges with one span of 100 feet, and one bridge with two spans of 100 feet. This is the point to which the trial location survey had been carried in October, 1875, and the result is to a certain extent satisfactory. The excessively heavy works through the Cascade Mountains, required on the line surveyed in 1872, have by the last survey been reduced to practicable limits. The length of tunnelling by the former was fully four miles; now it will not exceed two miles. The rock excavation and bridging over deep ravines have been reduced in proportion, as the formation line is now at a much less height above the level of the Homathco River. The gradients are also considerably improved.

On the other hand, the line by the River Nazco has not proved so favourable as was anticipated. The canyon at the head of the valley is eight miles in length with a continuous gradient of 1 per 100 and heavy rock cutting throughout. There is also some heavy work on two or three miles in the Blackwater Valley.

The length of line on which very heavy rock excavation and tunnelling occurs is about 50 miles, viz:—In the Cascade Mountains 40 miles; in the Nazco canyon eight miles, and in the valley of the Blackwater two to three miles. It is not necessary here to enter into a further classification of the works, as the quantities are being taken out from which an approximate estimate of the cost of construction will be obtained both on this and other lines. From Stewart River to Yellow Head Pass the line will be common to all those terminating at, or north of Bute Inlet.

The Divisions M and N have been engaged during last winter and spring in continuing the trial location of this portion of the line. A report has been received from the former, dated 15th January, 1876, accompanied with plan and profile of 22½ miles located from the summit of Yellow Head Pass westward. A subsequent report states that the party have been engaged during the winter running trial lines

in advance of location, and that they were prepared to resume the latter as soon as the country was clear of snow. A branch of the River Fraser rises on the west side of the Yellow Head Pass within half a mile of the summit, which is the eastern boundary of the Province of British Columbia. The river flows westward through Yellow Head and Moose Lakes, and the line is located on the north side of these to within four miles of the foot of the latter lake.

In the distance located—22½ miles—the fall is 313 feet. Of this fall 93 feet takes place in the two and a half miles from the summit of the pa s to Yellow Head Lake, in which there is a gradient of 1 per 100 for a mile and a half. The rest of the fall is between the two lakes, on which there are two gradients of 1 per 100, making altogether a length of two miles. On the shores of the lakes the gradients are undulating and easy. The works on this section will not be heavy; a few of the cuttings will reach 20 to 30 feet in depth, but chiefly in sand and gravel, with a few short cuttings in rock.

A report from the Engineer in charge of Division M, dated May 2nd, 1876, states that the party had been running trial lines during the winter, but resumed location on the 29th February, and they had reached and crossed the River Fraser 20 miles above Fort George. A plan and profile accompanying the report show this section to be 29 miles in length.

The distance from Bute Inlet to the junction of the Chilacoh and Stewart Valleys has been stated to be 289¾ miles. From this point the line has been continued along the right bank of the Stewart River, crossing the latter near the 297th mile. It follows the left bank to the 302nd mile, when it makes a sharp turn to the north up a narrow valley parallel to the Fraser. At the head of this valley—308th mile—is the summit of the divide between the valleys of the Stewart and the Fraser. From this summit the line descends obliquely the slope of the latter, and crosses the river at the 318½ mile. The line on the banks of the River Stewart and the lateral valley up to the 301st mile is on fertile flats, with easy gradients and the work will be light. The altitude at the crossing of the River Stewart is 1,950 feet above sea level. The river is 500 feet wide with 20 feet depth of water and a rapid current. The bridging of this will be a difficult piece of work. The ice piles up on the sides of the river to a height of five to ten feet. The summit of the divide is at 307½ miles, and, ascending this on the south side there are three lengths aggregating three miles of 1 per 100, and, descending the north slopes, there are five miles of the same gradients on three lengths, with short pieces of level between. Crossing the divide from 306 to 313 miles, the country is serrated with sharp ridges and narrow deep ravines, on which there will be very heavy excavations 20 to 60 feet in depth, chiefly in clay. On the rest of the distance the works will be very light. The Salmon River is crossed at 316¾ miles. It is 80 feet wide, but subject to overflow its banks. The Fraser, where the line crosses, is 700 feet wide, between walls of solid rock; it is 30 feet deep at flood with a very rapid current. This crossing only appears suitable for a suspension bridge, and it may be found necessary to select a crossing where the river is not so contracted, and the current is less swift.

Character of the Line from Dean Inlet to the Blackwater Valley.

The line of this preliminary survey runs up the valley of the Salmon River, which rises in the central plateau and flows nearly due west through the Cascade Mountains to Dean Inlet; it then crosses the watershed to the head of the Blackwater, which river flows nearly due east to the Fraser. The line follows this to the intersection of the line from Bute Inlet. Thence to Yellow Head Pass is common to both lines. Topographical sketches and some cross sections were taken to a sufficient breadth to project a line for location, and, as a location survey is now in progress of that portion of the line through the Cascade Mountains, it is not necessary to enter very minutely into a description of the preliminary line. The following table shows the gradients taken at points where there is a very decided change in the rate of inclination, disregarding minor variations. The remarks in the margin will sufficiently indicate the character of the country and works required.

Table of Gradients.

Length.	Gradient.	Remarks.
½ mile	Level	On flat tongue of land, south shore of Kamsquot Bay.
2 miles	53 feet per mile	A quarter of a mile of this is through a canyon. Rock cutting.
17 miles	31 feet per mile	The line is on the wrong side of the river with a large quantity of rock cutting and some tunnelling. On the other side are timbered flats with rock coming to the water's edge for a short space at three different points. Line being located on that side will cross river near 19th mile.
8½ miles	49 feet per mile	None of the cuttings will extend 35 feet in depth, but will be chiefly in rock.
2 miles	42½ feet per mile	
3¾ miles	80 feet per mile	Tunnel half a mile in length through rock. Rest of the cutting moderate.
¼ mile	Level	At Yeltesse or Salmon House, cross river 150 feet above water with bridge 900 feet long. One span of 200 feet over the chasm and 7 spans of 100 feet with a height of 40 to 50 feet.
3½ miles	26½ feet per mile	Heavy rock cuttings.
6¾ miles	70 feet per mile	
2½ miles	166 feet per mile	The canyon. Very heavy work.
3¼ miles	90 feet per mile	To head of canyon. Heavy rock cuttings.
2¼ miles	100 feet per mile	Heavy rock cuttings.
52¼ miles		

At Yeltesse, 34th mile, is a fixed point, and the line cannot be altered. It will be seen that, with the exception of a half a mile of tunnelling, there are no very great difficulties up to this point and the gradients are not bad. Here we are entirely through the superior snow-clad ranges of the Cascade Mountains, and from the head of the Canyon to this point the river finds its way in a deep groove through the rolling hills of the central plateau, and the greatest engineering difficulties will be on 16 miles from Yeltesse upwards. It is possible that a uniform gradient of about 84 feet per mile could be obtained with heavy rock cuttings and little, if any tunnelling; but a careful location survey can alone determine this.

The altitude at the 52nd mile is 3,003 feet above sea level. The line follows the north bank of the river to 59½ miles, where it commences to ascend the slopes of the valley of the plateau which divides the head waters of the Salmon River and the Blackwater. Following a chain of small lakes it reaches the highest point of the divide near Basalt Lake, at 86¾ miles, 3,700 feet above sea level. In ascending to this plateau the highest gradient is 1 per 100 in four lengths, making together a little over seven miles. The gradients on the plateau are easy and undulating.

From the 52nd to the 55th mile there will be heavy rock excavation, thence to the summit the rock will be moderate. The cuttings will be generally under twelve feet in depth; a very few will reach twenty-five feet, and nearly all will be in sand and gravel.

Near the 87th mile the line runs at the foot of a range of basaltic columns along the north shore of a small lake, less than a mile in length, which is one of the highest sources of the Blackwater.

From the 90th to 92½nd mile it runs along the north shore of Lake Eliguck, the second in the chain through which the Blackwater flows and which contributes to its supply. Thence the depression in the plateau becomes a defined, broad, but not deep, valley, and the line runs on the north side of it at some distance from the river, passing the junction of the two branches near the 101st mile; the larger branch coming down from a high range to the south west.

The line across the river—120 feet wide—at 110¾ miles, near the head of a small canyon; altitude 3,400 feet. From the summit to this point, the gradients are undulating and easy, there being only one piece of 1 per 100 two-thirds of a mile in length. The works will be light; few of the cuttings exceed 10 feet and will be

chiefly in sand, gravel and boulders. From the crossing, the line follows the right bank of the river through the canyon, which is about a mile in length with a base of 67 feet.

From 113 to 125 miles the line follows the south shore of Lake Thracha, through which the Blackwater flows, and at 134 miles near the foot of Lake Euchinico it re-crosses the river. In this section the gradients are generally easy, but the ground is more broken and the work will be rather heavy, as there is a considerable portion of rock in some of the cuttings. It is probable that a better line could be found by keeping on the left bank of the river and lakes all the way down. The altitude at the crossing of the river near the 134th mile is 1,335 feet. Thence the line runs on the left bank of the river, which flows through a chain of small lakes to the 160th mile. The gradients are easy on this section, but there will be some rather deep cuttings on the shores of the lakes, which, however, can be much reduced by a careful location of the line.

The last point is 3,017 feet above sea level and from it the Blackwater makes a sharp bend to the south-east till it meets the Nazco. The combined streams bend to the north-east. To cut off this angle, the line has been run over the ridge which has caused the deflection of the river. The summit is near the 166th mile—altitude 3,228 feet. In descending the Iskultasley, a tributary of the Blackwater, there is a gradient of 1.87 per 100, equal to 99 feet per mile, for $3\frac{3}{4}$ miles, and another of 1 per 100 for a mile and a half; but this can be improved to a uniform gradient of 1 per 100 for about nine miles, or, probably much better by a considerable deviation of the line to the northward. The excavations on this side of the ridge will be heavy, but principally in sand and gravel or loose rock. The Iskultasley River, 20 feet wide, is crossed between the 171st and 172nd mile; thence the line follows its left bank to the Blackwater Valley, where it joins the line from Bute Inlet, which enters the Blackwater by the Nazco Valley ten miles further up.

The length of the line from Dean Inlet to the junction is 184 miles, and from Bute Inlet 230 miles—a difference of 46 miles in favour of the former, with generally lighter works throughout, and it is anticipated that by a deviation of the line so as to form a junction with that from Bute Inlet in the Chilacoh Valley, the heavy work, which is now common to both lines, between the 230th and 260th miles will be much reduced. A survey of this is now being made.

From Kemano Bay, on the Gardner Channel, to First Lake on Eastern Slope of the Cascade Mountains.

This survey was an attempt to cross the Cascade Mountains from the Gardner Channel to Lake François in order to take advantage of the comparatively low line of country stretching from this lake to the Fraser near Fort George, by the Nechacoh and Stewart Valleys. Explorations with heights taken with the barometer in 1874 gave no promise of a practicable line across the Cascade Mountains north of the 53rd parallel of latitude, but this route was thought of so much importance as to merit a better instrumental survey.

The line commences on a bay at the mouth of the Kemano River, about 20 miles from the head of the Gardner Inlet, and follows the Kemano Valley nine miles, in which the rise is 175 feet. The valley is narrow and subject to overflow during the freshets from the melted snow in summer and the rains of autumn. The mountains rise precipitously from each side of the valley in masses of bare rock. At the ninth mile, the line leaves the Kemano Valley and takes a more easterly course up a lateral ravine through which a stream flows from a small lake near the summit of the mountain. The slopes of the ravine are steep and rugged and avalanches of snow and loose rock roll down them and sometimes choke up the ravine to a great depth. The summit of the mountain is reached at the 19th mile, where the latitude is 4,019 feet. At 22 miles the line reaches the head of the first lake on the eastern slope of the mountains, from which the water flows to Lake François or the Nechacoh River. The

line was carried along the north shore of this lake four miles; its length is estimated at from 18 to 20 miles and its altitude 2,790 above the sea. To construct a railway on this route would necessitate works of a costly character.

Survey of the Kitlope Valley from the Head of Gardner Inlet.

During the months of February, March and part of April last a survey of this valley was attempted. The surveyors found the Gardner Channel or Inlet covered with fixed ice for 25 miles from its head, and the party were detained by storms of snow and rain, which partly broke up the ice, so that it was a month before they got all their baggage and supplies to the head of the Inlet and commenced work. They continued the survey 46 miles and had then struck the Chatsquot River, which flows into the Dean Inlet, where they were forced to discontinue the survey as the snow was 12 to 14 feet deep and was becoming soft, and avalanches of snow were rolling down the mountain sides into the Kitlope Valley.

I have the honour to be, sir,

Yours etc., etc.,

MARCUS SMITH.

Sandford Fleming, Esq.,

Engineer in Chief.

APPENDIX J.

REPORT ON WINTER EXAMINATION OF INLETS, BRITISH COLUMBIA, BY C. H. GAMSBY.

VICTORIA, B.C., 18th April, 1876.

SIR,—In accordance with your instructions, having procured the necessary outfit, we sailed by the steamer "Sir James Douglas," Capt. Morrison, on the 2nd February ult., for the head of Gardner's Inlet, to explore from that point, *viâ* the valley of the Kitlope River, across the summit to Tochquonyala Lake. We met with no obstructions in our voyage up the coast, and on the evening of the 8th February entered Gardner's Inlet. About noon we reached the ice, which extended quite across the channel, and as far up as we could see; on examination we found it eight inches in thickness and quite firm. The steamer could go no farther As the shores of the inlet are rock, nearly perpendicular, it was impossible to disembark except upon the ice. A safe anchorage became the first requisite. This the captain found, after a long search, in a small bay on the south-west side of the inlet, at the mouth of a river named by the Indians Kiltoyse, about four miles from the ice. The following morning we were early at the ice. I sent Mr. White ahead with two men to examine it and look out for camping ground. In the meantime, the remaining men were set to work preparing the supplies for transportation on toboggans and sleds. Mr. White and party returned at 5 p.m., accompanied by some Kitlope Indians. He reported that he had reached the Indian village at the mouth of the Kemano River, which must necessarily be our first encampment. He estimated the distance at eight miles. From this data we made the distance from the commencement of the ice to the head of the inlet, to be twenty-five miles. The Indians informed us that the ice was quite strong the whole distance. At my request, Captain Morrison reluctantly allowed the steamer to remain kedged to the ice during the night, to enable us to get off as early as possible. Fortunately for us, he kept steam up all night, for before daylight a fierce storm of rain and wind from the north-east struck us, the ice commenced breaking up along the water's edge, the kedge gave way, and had the boat not been under steam we must have been driven against the bluffs. We reached our anchorage at Kiltoyse in safety. As the day advanced the storm increased; the thick falling snow obscured everything. The wind, tearing along the mountain tops, loosed large masses of snow, which rushed down the crevasses, and, increasing in magnitude and velocity as they descended, finally plunged into the surging waters of the inlet with a dull, sullen boom like the discharge of distant artillery. This storm raged without abatement for eight days. On the ninth there was a short lull, and we started for the ice; before we reached it, the storm returned with increased violence from the south-east, bringing torrents of rain. We returned to our anchorage and were again shut in for seven days. During our detention here this last time we observed large masses of floating ice in the inlet; this led us to hope that the ice had broken up, and that the steamer would be able to reach her destination. We ran up to the ice, and found, to our great disappointment, that the storm, assisted by a spring tide, had removed less than two miles of the ice. There was now eighteen inches of snow and water over what remained. Frost was now our only hope; it set in on the 25th February, and early on Monday, the 28th, we were on the ice pushing for the level

ground near the mouth of the Kemano River, which we reached the same night. As we were unacquainted with the inlet, some one of the staff was always seven to ten miles ahead of the main party. On the third day out from the steamer Mr. White, who was scout for the day, reported open water seven miles ahead. The Deputy Purveyor sent at once to Kemano for two canoes. They arrived next day. I manned one and started ahead to explore. I passed over two miles partly thin ice, which the Indians broke with long poles; partly drift ice, which we hauled our canoes over, the remaining distance of two miles was open water, which we crossed, landing at the deserted Indian village at the mouth of the Kitlope (Indian name Khustawah; Kitlope being the name of the tribe of Indians living here.) On March 6th, the weather was very cold, the thermometer at night reading zero. We commenced crossing supplies, but the ice formed so fast that the men were obliged to break it both going and returning, making progress very slow. The cold increased so much that on the 8th, we could no longer break the ice. I decided to haul everything over it if possible; I went first, selecting the apparently strongest places; the Indians followed with canoes, and the men with loaded toboggans and sleds. We reached the open water safely, launched our canoes, loaded them, and crossed over to the mouth of the river. At 7.30 p.m. we had all reached our starting point. Having adjusted our instruments and taken observations for latitude and meridian, we established our initial point on the north-east shore of the inlet, at the deserted Indian village mentioned above, by planting a post marked: C.P.R.S., Division X, 1876; latitude, 53° 12′ 20′.

From this point the general bearing of our exploration was a little south of east for 24 miles along the Valley of the Kitlope. About one mile from our starting point we crossed a fair sized stream coming from the north, called by the Indians "Tseetish." This I explored for about four miles, and from the quantity and size of the drift wood, judged that it was a formidable stream during the warm season.

I have instructed the topographer to make a tracing of his work to accompany this report.

You will see by this tracing that from our starting point to the first rock bluff, a distance of three miles, the line passes over a low grassy flat, very little above tide water, and very much cut up with sloughs and water courses.

At this bluff we first meet the river in one channel, 500 feet wide. Continuing along the river from point to point, at the eighth mile, we meet a stream falling into it from the south. This stream flows out of a lake close at hand, the shape and bearing of which corresponds to the lake called "Beaver Lake" on a tracing taken from the office here, showing the topography of Kitlope Valley, but it is much larger, being from eight to nine miles long and nearer the coast by some seven or eight miles. It is only fifteen feet above sea level. About two miles above this the ice disappeared entirely from the river, and the line was run along the shore and across the flats wherever it was most convenient; crossing, and re-crossing portions of the river, sometimes on felled trees, at others, where there were no trees, wading. At the 20th mile we cross a stream coming in from the north-west, called by the Indians, "Tenaicoh;" it is about two-thirds the size of the main stream. At the 24th mile, we cross the main stream, elevation at this point 200 feet above sea level. Leaving the Kitlope at this crossing, we follow a stream coming in from the north-east, called 'Kahpellah." This stream is very rapid, and at two miles from the crossing, or 26 miles from the coast, we reach the entrance to a canyon. The elevation attained at this point is 407 feet. We were forced to discontinue our traverse at this canyon, and explore with compass and aneroid. Ten miles from the entrance to the canyon we reached the summit at an elevation of 1,150 feet. One mile due north from the summit, we struck Tochquonyala Lake, its elevation is 1,000 feet; it lies due north for two miles, then north-east for one and a half miles, and is about 30 chains in width. A fair sized stream flows from the north-east end of the lake; its course is north 20° east for six miles, when it falls into a much larger stream coming from the north-west and flowing south-east and south. The elevation at the junction of these streams is about 700 feet, and the whole distance from our initial point at the head of Gardner's Inlet 46 miles. The Kitlope Indians call this large stream

"Chedsquit," and affirm that it flows into the head of Dean's Inlet. We also learned from them that the source of the "Chedsquit" is a large lake, nearly due north from Tochquonyala Lake; distant two days' journey by Indian trail over the mountain, but much farther by the course of the stream, which makes a long detour to the westward, passing through very bad canyons. This lake they call "Tsoolootum," it is also the name of an interior tribe of Indians, whose winter houses are on its shores. During the salmon season they live at Tochquonyala Lake, where we saw their hurdles for drying salmon. While one party was exploring the pass over the summit, I sent another to examine the Kitlope. They explored about ten miles nearly due south; the river divides here, one part turning south-west, the other continuing nearly south, subdividing until they become small mountain streams. The valley of the Kitlope is a deep basin, its greatest length being about 36 miles, and its greater elevation about 250 feet.

Streams fall into this basin from all points, forming the main stream or Kitlope. These streams all rise on the western slope of the Cascade range. The only exit from the valley is by the pass explored, and this only a divide between the waters flowing into Gardner's and Dean's Inlets.

Having ascertained that Lake Tochquonyala was not the summit, nor near the summit of the Cascade range, and that there was no possibility of reaching that summit by this route, I decided to return. The weather had been quite warm for some days, the snow was becoming very soft and the stream was rising fast. Our return journey was labourious and slow, we broke up camp on Tuesday, March 28th, and reached the coast on April 3rd.

We were surprised at not finding the steamer, as there was no ice in sight.

On making an examination the next day, I reached the ice about five miles from the head of the Inlet, about one mile having broken up during our absence. The weather was unfavourable, raining continually. An Indian family which had come over the ice a short time previously to our arrival, informed us that two or three canoes would be up in the course of a day or two. We decided to wait their arrival; in the meantime we surveyed the shoals at the head of the Inlet, and took soundings for anchorage. These are shown on the tracing accompanying this, and need not be described here.

The canoes arrived on the 10th April; the weather was clear and frosty at night. We struck our tents at two o'clock a.m. on the 11th, determined to reach Kemano that day; we were at the ice at daylight, loaded our toboggans and set off. There was about eight inches of water over the ice; this was frozen sufficiently to bear toboggans, but not the men, it made travelling very bad. The ice was sound excepting in the vicinity of the vertical rock bluffs where it was very rotten; but we only had five men through it during the day with no worse consequences than a very cold bath. I reached Kemano at one o'clock p.m., and sent a message to Capt. Morrison requesting him to be at the ice with the steamer the following morning. We encamped here and the rest of the party were all in before night. The next morning we were obliged to transfer our baggage from toboggans to canoes. The rain had fallen all night, and the upper ice melted so that there was now about one foot of water over the ice. We attached six to eight men to each canoe according to its size and set off. In the vicinity of the snow slides the ice was bad, and nearly all were through some two and three times during the day. We found the steamer awaiting us at the termination of the ice; of which two miles had worn away during our absence.

As soon as all were on board, the steamer returned to her old anchorage at Kiltoyse Bay. We left very early in the morning and run until midnight anchoring at a small bay near Bella Bella. Next morning spoke steamer "California," the Captain informed us that the steamer "Otter" had gone into Dean's Inlet looking for us. Captain Morrison ran fifteen miles up the Inlet, but saw nothing of her. Being short of fuel he turned back and ran for Victoria, where we arrived safely on the 16th of April, at half past five o'clock p.m. This closes the record of the exploration, but as my experience of the ice formation, snow-fall and snow-slides was quite different from what was anticipated, I will briefly refer to them.

Ice Formation.

Gardner's Inlet.

As has been already stated, we struck the ice twenty-five miles from the head of the Inlet, its thickness was then eight inches, which afterwards increased to eighteen inches. After passing over it we found about four miles broken up at the head. This breaking up I attribute to the heavy and continued rain that fell while we were at Kiltoyse Bay, assisted by the flooding of the Kitlope River. There can be no doubt but that the whole twenty-five miles of the Inlet had been completely frozen before this storm. The large masses of drifting ice would indicate this. The Indians informed us that it had been frozen one month at the time of our arrival, this would shew that it took early in January. On the 12th of April, there was still seventeen miles of ice, and although broken near the bluffs, no break extended across the Inlet. The Indians declare this the first time that the Inlet was ever frozen over below Kemano; they admitted that it had been frozen to a certain point which was about two miles from Kemano, but this only at long intervals, not generally. From my own observations, I infer that the portion above Kemano, say ten or fifteen miles, must freeze every winter. The Inlet is very narrow, the mountains rise almost vertically from the water, there being no foot hills, there is no stream falling in of a sufficient size to cause a break in the mountains through which the wind could reach the Inlet. It is perfectly land-locked and must necessarily freeze during a snow storm on a cold calm night.

Dean's Inlet.

I did not have time to visit this Inlet. I met some canoes from the head who said it had been frozen for a short time. Mr. Creighton who went up in the "Otter" saw no ice.

Bute Inlet.

Mr. Creighton learned from the Indians that there had been no ice during the winter.

SNOW-FALL.

On our arrival at Kiltoyse Bay we measured the snow on a small flat near the steamer, we found it four feet and one-half deep, but so light that a man in walking would sink quite through it to the ground. During the eight days' storm at Kiltoyse the snow fell fourteen inches on an average every twenty-four hours, this would give an increase of nine feet four inches, which, added to that already on the ground, would give a total depth of thirteen feet ten inches, say fourteen feet. After the cessation of the rain, when the snow was again measured it was found to be six feet in depth, but it was now so compact that a man could walk over it. As we ascended the Kitlope Valley the snow increased in depth. Seven miles from the coast it was eight feet deep and so hard that the cook, in clearing it away for his fire, was obliged to cut a great portion with an axe. From marks on the trees it appeared to have been from sixteen to twenty feet before the thaw. On the summit at an elevation of eleven hundred and fifty feet the snow was from twelve to fourteen feet deep, the top layers very light, making it very difficult travelling. If Tochquonyala Lake had been at any greater elevation we could not have reached it. As it was, we had two trials before we reached the lake, both parties were snowed in, the first at the summit, the second, four miles down the outlet of the lake. The distance from that point to the Chedsquit, and the elevation at the junction were estimated by the last party.

SNOW-SLIDES.

In the high latitude of our exploration, the snow-slides are truly formidable along the shores of Gardner's Inlet; they occur at short distances and are of great magnitude. In many places acres of snow, broken timber and large boulders are spread out over the ice. Along the valley of the Kitlope, they occur along the south-western slope or north-eastern exposure of the mountain, where they are from fifty to one hundred feet in depth, many of them reaching quite across the river. The north-eastern slope or south-western exposure is free from slides, a belt of foot-hills intervening between the valley and snow peaks intercept the slides. After reaching an elevation of one thousand feet, they occur indiscriminately on both sides of the valley. At Toch-quonyala Lake the whole distance of three miles and a half on the south-western side is one immense slide. They also occur on the opposite side, but not in such magnitude. In conclusion, I must beg indulgence for the imperfections of this report, as, deeming it of great importance that it should be in your hands at the earliest moment, I have hurried it through in time for to-morrow's mail.

Respectfully submitted,

C. H. GAMSBY,

Engineer in Charge Division X., C.P.R.S.

To Marcus Smith, Esq.,
Deputy Chief Engineer, C.P.R.S.,
Western Division.

APPENDIX K.

MEMORANDUM REGARDING THE SURVEYS IN BRITISH COLUMBIA, GIVING AN OUTLINE OF OPERATIONS CARRIED OUT DURING THE YEAR 1876, BY H. J. CAMBIE.

OTTAWA, March, 15th, 1877.

SIR,—In accordance with your request, I have prepared the following memorandum regarding the surveys in British Columbia, giving an outline of operations carried out by the parties under my charge, in 1876.

On receipt of instructions to take charge of surveys, I left Ottawa on April 20th, and arrived in Victoria, British Columbia, on May 2nd. Arrangements were at once made for despatching the various parties to their destinations without delay. There were seven engaged in the field during the season,—five on location, and two on exploratory lines. The first one left Victoria on May 11th, while the last got away on the 26th.

Division N, under Mr. Bell, had continued in the field in the neighbourhood of Fort George during the winter, and at the earliest possible moment, proceeded with the location eastward towards Yellow Head Pass.

Division M, under Mr. Keefer, had also wintered in the field, near Tête Jaune Cache, and was now locating the line westward, to meet Mr. Bell. Their surveys were connected on October 5th. But as it seemed in the month of May to be improbable that these two parties could complete the location before the end of the season, Division V, under Mr. Trutch, was sent to their assistance, by way of Kamloops and the River Thompson. Freshets on the North Thompson, caused the loss of some supplies, and detained the party so much, that they did not get to work till August 1st.

About twenty miles of the line, up the east branch of the Homathco, had not been located in 1875, and Division X, in charge of Mr. Gamsby, proceeded by way of Bute Inlet, to complete this, and revise some portions of the location on the lower Homathco, which it was hoped could be improved. This work was finished on October the 19th, and the party reached Victoria on the 22nd.

Mr. Jennings took Division R to Dean's Channel, to locate a line up the valley of the Salmon River, for about fifty miles from the sea; at which point it is fairly through the Cascade range of mountains, and has gained the interior plateau. This party finished their allotted task on September 27th, and arrived in Victoria on October 7th.

Division Y, under Mr. Hunter, was detailed to commence at mouth of Iltasyouco River, which enters the Salmon River about forty-four miles from Dean's Channel, and make an exploratory survey eastward, by way of Lake Kwhulcho, and the valley of the River Nechaco.

It was hoped that a line by this route would prove shorter, and have a lower summit than that already surveyed, by way of the Blackwater and Chilacoh Rivers.

Division S, under Mr. McMillan, went to mouth of Chilacoh River, and ran a line up the valleys of the Stewart and Nechaco Rivers, to meet Mr. Hunter; which they did on September 29th.

I proceeded up Salmon River, on June 13th, accompanied by Mr. Hunter, who had just completed a survey of the head of Dean's Channel. We expected to reach his starting-point, at the mouth of the Iltasyouco, in four or five days, and to find a mule-train there awaiting our arrival with a supply of provisions.

Excessive freshets in the Salmon River detained us for several days; and a similar cause having detained our pack-train, which was coming from Quesnelle Mouth, Mr. Hunter was unable to commence work till July 5th.

In proceeding up the Salmon River, it was evident that the unusual freshets were caused by the unprecedented snowfall of the previous winter, which was then being thawed rapidly by the hot sun of June.

For thirty-four miles from the sea the mountains rise precipitously, or at very steep inclinations, for several thousand feet on each side of the valley, and throughout that distance the effects of the snow were visible in avalanches as well as freshets. Most of them descended the same courses which had been swept by similar ones in former years. But others had come down hill sides, thickly wooded, carrying everything before them and depositing piles of broken timber, rocks and snow, which in some cases exceeded forty feet in depth, even in July.

In locating the line up this valley, places subject to avalanches were avoided with three exceptions, and it is proposed to tunnel in the rock under one, and bridge over the other two.

As you had expressed a desire to have the country to the southward and westward of Lake François examined, I made a trip there, leaving Fort Fraser on August 25th, I reached the western end of Lake François on 30th, and on September 6th ascended a spur of the Cascade range of mountains from which my guide pointed out Lake Talsabunkut, one of the principal sources of the Nechaco, about six miles distant.

The survey which was made from Gardner's Inlet, in 1875, by way of the River Kemano, terminated at the western end of this lake and it was named on that occasion First Lake. I was informed that one branch of the River Skeena has its source in a small lake a short distance from Talsabunkut, and flows in a northerly direction to the main stream.

Lake Talsabunkut is drained by the River Tachla, which runs eastward for about forty miles and discharges itself into Lake Ootsabunkut.

In the above distance the river has an exceedingly serpentine course, very little current and numerous beaver dams in the sloughs which cause it to overflow much of the adjacent country; so much so that I was unable to follow the valley and had to travel by an adjacent one.

We paddled down Lake Ootsabunkut on a raft and did not abandon it till we had descended the River Tchutasely and Lakes Intata and Nahtalcus and reached the main River Nechaco, a distance of about seventy miles in all.

From the head of Lake Ootsabunkut, to the foot of Lake Nahtalcus, the valley is generally narrow, but the hills on either side rise with easy slopes most of the way.

Taking the eastern end of Lake François as a starting point, I had travelled upwards of 100 miles westward, and had returned by a course somewhat parallel, but considerably to the south.

This tract of country may be described as essentially a lake district. There is a belt of flat swampy land several miles wide, extending along the eastern base of the Cascade range for a considerable distance to the north and south of River Tachla, which has only a few trifling undulations, and is intersected by sluggish streams, dammed repeatedly by beaver, forming numerous ponds and small lakes.

Farther to the eastward, the country is intersected by ranges of hills of no great height, running parallel to each other and nearly east and west, with long narrow lakes lying in the valleys.

The southern slopes of the ranges are timbered with poplar, black pine, and a few spruce, but there are many open spaces covered with a luxurious growth of pea vine (vetches) and various kinds of grasses. The northern slopes sustain a dense growth of spruce, black pine, and a few Douglas fir and poplar of medium size and without any special value for economic purposes.

So far as I could form an opinion, this portion of British Columbia may, at some future day, be utilized as a pastoral country, and support large herds of cattle, but is not likely to be used for agriculture generally.

The Indians and officials of the Hudson's Bay Company raise potatoes, turnips and some grain at sundry favoured spots on the shores of Lake Fraser, also at Lake (Choka) Tachick, and other places of the same or less elevation, but the crops are often damaged by frosts. This, however, might possibly be avoided by an improved system of agriculture. They also keep a number of cattle at both the places mentioned.

No attempt is made to cultivate the land around Lake François, which is higher than Lake Fraser, while Ootsabunkut and the lakes to the south are higher still, varying in elevation from 2,700 feet upwards. They are also much nearer to the snow-capped peaks of the Cascade range of mountains, which affect the temperature very perceptibly. That district therefore would, in all probability, be found much less suited for agriculture than the shores of Lake Fraser. The natural grasses and pea vine however grow so luxuriously as to give promise of affording an abundant supply of food for cattle, if they were sown in land which had been cleared up and cultivated.

Having visited Kamloops early in October, and, while there, ascertained that all the parties had completed their work and were then on their way to Victoria, I determined to proceed there at once. travelling by way of Lake Nicola and Coquihalla Valley to Hope. I had reported on this valley in 1874, and having in the meantime seen some of the other passes through the Cascade range of mountains, now desired to examine it once more. A new trail had been opened a few days previously from Lake Nicola to Hope, which enabled me to do this without difficulty.

The character of the Coquihalla Valley is very similar to that of the east branch of the Homathco; but, in case of a line being located by this route, the length of very heavy work and steep gradients would be greater. The unusual snowfall of the previous winter had formed avalanches in places which showed no signs of such on my former visit.

Reaching Hope on the evening of October 12th, I received a telegram from the head office in Ottawa, regarding a survey of the River Fraser route, and on the 14th another despatch reached me on the same subject, the telegraph line having been down during the two intervening days. As the parties were coming down the waggon road in coaches, I managed to intercept those of Messrs. Keefer, Hunter and McMillan between Yale and Lytton, and put all three to work between those points.

The difficulties to be encountered in that section had been looked upon as the most formidable on the River Fraser route, and you had, in 1874, ordered a detailed survey there. A party under my charge then ran a line from Yale to Chapman's Bar (13 miles) but had to stop work on account of snow.

To complete that survey to Lytton seemed the most suitable work to undertake now that the season was likely to be very short, and as the weather was unsettled and it was uncertain when we might be obliged to cease operations altogether, I decided to put on three parties without specific instructions.

There were 40 miles to be surveyed, and the three parties accomplished this, though it rained almost without intermission on the two of them nearest to Yale.

Notwithstanding the rapid manner in which the line was run, it gave satisfactory results, and there is little doubt that, with more time at command, it could be improved very materially.

Messrs. Keefer and McMillan ceased operations on November 1st, and arrived in Victoria on the 4th. Mr. Hunter and his party, which was the last in, reached there on the 15th. This closed the season's operations.

I remain, Sir,

Your obedient servant,

H. J. CAMBIE.

SANDFORD FLEMING, Esq.,
Engineer-in-Chief,
Canada Pacific Railway.

APPENDIX L.

REPORT ON EXPLORATORY SURVEY BETWEEN LAKE WINNIPEGOOSIS AND LIVINGSTONE, DURING THE SUMMER AND AUTUMN OF 1874, BY GRANVILLE C. CUNNINGHAM.

OTTAWA, 6th February, 1875.

SIR,—Having completed the exploratory survey for the route of the Canadian Pacific Railway, from the Mossy River at the southern end of Lake Winnipegoosis to Fort Pelly, and having laid down on plan the position of the final location line, I beg now to submit the following report:—

The latitude at the commencement of the survey at the Mossy River is 51° 37′ 27″; the greatest latitude reached where we round the north-east corner of the Duck Mountain is 52° 06′ 00″; and the latitude at the termination of the survey at the Fort Pelly Police Barracks, is 52° 53′ 03″.

The length of the line surveyed from the Mossy River to the crossing of the Snake Creek at the Fort Pelly Police Barracks is 106 miles, but on the final location this will probably not much exceed 100 miles.

The course of the railway will be remarkably free from curves. From the Mossy River to the north-east corner of the Duck Mountain, a distance of fifty miles, there will be one unbroken straight. On the remaining fifty miles there will not be more than seven curves. With the exception of one curve of 2,865 feet radius, there will be no curve sharper than 5,730 feet radius (1°.)

The greatest elevation reached is 688 feet above the level of Lake Winnipegoosis, at a point 1½ miles to the east of the Fort Pelly Barracks. This elevation is attained by a gradual ascent throughout the whole length of the line, and in no instance will the maximum gradient 52·8 feet per mile be requisite.

The grading required to be done is very light, and the gradients obtained will be remarkably easy. At the commencement of the survey in the country lying to the south-west of Lake Winnipegoosis, I had been led to believe that the "Muskegs" or swamps would, owing to their great depth, offer serious difficulties in the construction of the Railway, but on examination I found that this was not the case. What may be called the swampy part of the line lies between the fifteenth and twenty-sixth miles. Here there is a succession of swamps separated by intervening strips of firm, well-timbered land. The worst of these swamps is about a half mile in width, and is seven feet deep. Though in its present state, it is impossible to cross with horses, and ti offers difficulties even to a man on foot, it is not objectionable for the line of railway, as it is easily drained and possesses a good clay bottom.

On that part of the line lying between the Mossy and Rolling Rivers, a distance of seventy miles, the streams to be crossed are unimportant, and will be easily bridged. At the crossing of the Rolling River (at 70 miles) we meet with the first work of any importance. This river flows in a valley one thousand feet wide at our point of crossing, and fifty feet deep. The bridge would require to be on the high level. After crossing the Rolling River, the character of the country changes somewhat, and instead of a flat, heavily timbered country drained by low banked streams, we have for the succeeding thirty miles a more prairie-like region bearing light bush, with here and there good bluffs of timber and traversed by wide and deep gullies through which small streams flow to the Swan River. Between the Rolling River and the termination of the survey, there are five of these gullies inclusive of that of the Snake Creek at the Fort Pelly Barracks. These crossings will be about 1,000 feet wide and from 50 to 80 feet deep. But with the exception of this necessary

bridging the expense of construction of this part of the line will be no greater than that of the preceding seventy miles and the gradients obtained will be equally as good.

The timber at the commencement of the survey at Mossy River is chiefly grey poplar, of sound quality and from 10 to 15 inches in diameter. The country here may be described as alternate strips of timbered land and meadow, the timbered land bearing to the meadow a proportion of about two to one. This character of country and timber gradually changes as we ascend towards the Duck Mountain—the timber becomes larger and the "opens" fewer. At a distance of about five miles from Mossy River we met with spruce and tamarac. At first, the trees are small—not exceeding 12 inches in diameter—but by the time 15 miles is attained excellent spruce of 18 inches in diameter are easily obtained in large numbers. On the belts of firm land lying between the swamps before alluded to at this part of the line, a plentiful growth of fine timber—spruce, tamarac, poplar and birch—is available for the construction of the Railway. As we continue, the size and quantity of the timber increases. At 30 miles, many white spruce, 2′ 6″ in diameter and of thoroughly sound quality, together with large tamarac and poplar, can be obtained. From here on to the 50 miles, where we turn the north-east corner of the Duck Mountain, this heavy character of timber is maintained. On the line of Railway between the 40 and 50 miles, I observed some white spruce trees 3′ 6″ in diameter. On the Duck Mountain itself, and on the spurs running out from it, there is a magnificent growth of white spruce, a very large part of which would be within easy distance of the line of Railway. This white spruce is well suited for bridge building. The quality of the timber is almost equal to that of first quality pine, and it is remarkably sound. I did not observe the smallest symptoms of decay in any of the trees that were cut.

On turning the north-east corner of the Duck Mountain, we enter the valley of the Swan River, and here the timber is not so good, owing to the fact of the country having been burnt over some ten years ago for a distance of about 20 miles along the line of Railway. The large timber has consequently fallen, and a thick undergrowth of poplar has sprung up. There still remain, however, occasional bluffs of timber, particularly at the crossings of the different streams, from which a good supply of spruce and poplar can be obtained. Up to the 60 miles the line skirts the base of the Duck Mountain which is heavily timbered as previously described.

After crossing the Rolling River at the 70 miles as before, mentioned we enter a more prairie-like district, and the timber, as a general rule, is very light with intervening stretches of prairie, but in the river valleys and gulleys that are crossed, timber bluffs affording white spruce and tamarac are conveniently situated for use in the construction of the Railway. At the 90 miles the line approaches to the Swan River. Here the Swan valley narrows into a gorge about a quarter of a mile wide and 100 feet deep, and in this gorge there are bluffs of pine and spruce which continue for about five miles; from this point up to the Fort Pelly Barracks, a distance of five miles, there is no timber available on the line of Railway. On crossing the Snake Creek, however, at the Barracks, we again enter a richly timbered country which extends, I was informed, for about 15 miles to the west.

It will thus be seen that for the length of line surveyed from the Mossy River to the Fort Pelly Barracks, with the single slight exception noted above, timber can be obtained on the line of railway in sufficient quantities to meet the requirements of construction, and for a considerable distance, namely, from the 25th to the 60th mile the timber is of such quality, and in such quantity, as to render it valuable as an article of commerce.

Throughout the length of the line, with the exception of the last ten miles, the soil is rich and fertile. On the banks of the Mossy River there is a strong loamy clay, producing rich vegetation. Farther on we reach the meadows before alluded to, where there is a very luxuriant growth of long grass. In these meadows are to be found small lagoons of salt water, whilst sometimes, occasionally in close proximity to salt, there may be seen a spring of perfectly pure water. This salt water is not met with after the fifth mile. The swamps mentioned between the

fifteenth and twenty-sixth miles would for some time be an obstacle to cultivation, through it is probable that the drainage caused by the construction of the Railway would do much towards their improvement. After this is passed we enter upon a better drained country, and the strength of the soil is evidenced by the luxuriant and varied undergrowth in the forest, together with the numerous kinds of grasses produced. It is in the Swan Valley, however, that the richest and most extensive area of agricultural country is found. The valuable part of this valley, or rather basin, begins at the eastern slope of the Thunder Hill, and extends in a north-easterly direction to the Swan Lake. It is bounded on the north and north-west by the Swan Lake and Porcupine Mountain, on the west by the Thunder Hill, on the South by the Duck Mountain, and on the East by an elevated ridge lying between it and Lake Winnipegoosis. Its extent is about 60 miles in length by 20 miles in width. The soil is remarkably rich and productive. Throughout, it consists of large plains clothed with tall suculent grass alternating with strips and clumps of timber well-grown and admirably adapted for building purposes. At the lower end, that is near the Swan Lake, the timber is more varied than in any part of the country as yet described. Here one may see spruce, tamarac, oak, elm, maple, birch and poplar; each species being represented by trees of very considerable growth. In the gardens attached to a few houses forming a little hamlet at the mouth of the Swan River, I had ocular demonstration of the productive power of the soil. This valley is looked upon by the natives as the garden of the district.

On the last ten miles of the line running along the edge ot the gorge of the Swan River, the soil is stoney and light. About a mile to the south, however, these stones disappear and the soil is richer.

At the 45th and 47th miles are ridges elevated from 12 to 15 feet composed of sand and gravel suitable for ballast. Again, from the 55th to the 62nd mile, at an average distance of 500 feet, the line runs parallel to the base of the Duck Mountain, which here rises to a steep slope, and from which gravel and sand can be obtained.

In some of the streams in the Duck Mountain traces of iron could be detected in a few of the stones composing the bottom, but these, I am inclined to think were the remains of boulders rather than the evidences of iron stone *in situ*.

The climate is similar to that of the Province of Manitoba. In summer the days are hot and the nights cloudless and cool; this difference of temperature causing a heavy dew-fall, which compensates for the almost total want of rain. In the autumn, the more equitable temperature of the nights and days, combined with cloudy weather, reduces the dew-fall to almost *nil*; there is the same absence of rain, and the country consequently becomes so dry that much inconvenience and even danger is caused by bush fires. The first frost was observed on the 15th September, on which night there were two degrees of frost. After this, however, as late as the middle of October mild and genial weather was experienced. The first snow fell on the 25th October, and this snow continued on the ground. After this the weather set in steadily cold. On the night of the 17th November the thermometer registered —19°, and again on the 25th of the month—34°. Soon after this, the thermometer, to my regret, was broken, but I was surprised to find, on reaching the Fort Pelly Barracks on the 19th December, that in the middle of the month the thermometer had on one night registered —41°. Owing to the great dryness of the atmosphere, combined with the protection from wind the bush afforded, we had not suspected that we were exposed to such intense cold; indeed, I may mention that some of my men who came from Marquette county, in Michigan, in drawing a comparison between the two districts had decided in favour of the North-west as being the milder, though no doubt even —20° in Marquette would have caused much discomfort. The depth of snow observed in the end of December was about 8 inches. In regard to early summer frosts, from which this district is supposed to suffer, the testimony of some few half-breed settlers in the Swan Valley and on the shore of Lake Winnipegoosis, was to the effect that these early frosts are unknown and that in every way the climate is well adapted for agricultural operations. On the other hand, at the greater altitude of Fort Pelly, the opinion of the gentleman in charge of that post was that the early frosts might in

some seasons, be injurious to wheat; at the same time barley and all kinds of garden vegetables are successfully raised at the post.

While speaking of agriculture, I may perhaps mention as a fact of considerable importance, that a grasshopper plague, such as, during the past few years, has devastated parts of the Province of Manitoba, is unknown in this more northern bush region. Last summer while the Province of Manitoba suffered, the district where my survey lay was entirely free from this most destructive pest.

At Mossy River, the railway crossing is a little over a mile from the southern end of Lake Winnipegoosis. At the point of crossing the width is 125 feet. About 50 feet below this, however, the river widens to over 200 feet, affording ample accommodation to vessels plying on the lakes. The depth of water varies between five and seven feet; the bottom is composed of clay and gravel. On the final location, the line of railway again comes within a short distance (about 2,000 feet) of the south-west end of Lake Winnipegoosis, but here the depth of water is only some two to three feet, rendering it almost useless for shipping purposes.

In the Swan Valley the Swan River is navigable for boats drawing two and a half feet of water for a distance of about 20 miles* up from the Swan Lake. The Swan Lake, again, is connected by a navigable river with the northern end of Lake Winnipegoosis

In regard to the continuation of the line to the west of the Fort Pelly Barracks no difficulties of any moment present themselves. On crossing the Snake Creek at the Barracks the country rises by an easy slope to a higher plateau, and this plateau continues to the west in easy undulations.

I have the honour to be, Sir,

Your most obedient servant,

GRANVILLE C. CUNNINGHAM.

Engineer in charge Division, P.

To SANDFORD FLEMING, Esq.,

Engineer in Chief,

Canadian Pacific Railway.

*This point would be about 25 miles distant from the line of Railway.

APPENDIX M

PROGRESS REPORT ON THE SURVEYS MADE IN THE NORTH-WEST TERRITORIES DURING THE YEAR 1875, BY H. A. F. MACLEOD.

OTTAWA, 28th March, 1876.

SIR,—I have the honor to submit the following report on the preliminary surveys and explorations for the Canadian Pacific Railway, made during the season of 1875 in the North-West Territories, between Livingstone, near Fort Pelly and the Caledonian Valley, the eastern approach to the Yellow Head Pass in the Rocky Mountains.

Your telegram of the 13th March, 1875, directed me to take charge of the instrumental surveys to be made from Fort Pelly to Jasper Valley and explorations in the Rocky Mountains, and your written instructions of the 25th and 31st March gave me definite directions as to the manner in which you wished to have the service performed.

The immediate object of the survey was :—

Firstly,—To ascertain how far it would be practicable to run the line of railway through the outlying spur of the Rocky Mountains, between Caledonia Valley, which leads to Yellow Head Pass. and the North Saskatchewan, by way of Brazeau River.

Secondly,—To connect the surveys already made east and west.

You supplied me with copies of the Earl of Southesk's book, Captain Palliser's reports and maps, and other information. On the maps you marked the general direction of the lines you wished to have surveyed and explored.

I was directed to arrange with Mr. Lucas, in charge of Division P, to begin an instrumental survey at Fort Pelly with his party, and to extend westward along the general direction of the line shown on the maps, selecting the best ground that could be found to a point to the south of Edmonton, and to take my old party—Division L, in charge of Mr. H. N. Ruttan—with me, to begin where Moberly's survey terminated, near Root River, and run eastward to meet Lucas' party, crossing the North Saskatchewan at the most suitable point, probably near the "Old White Earth Fort."

You advised me to send Division L to Root River *viâ* Carlton and Fort Pitt, and directed me, if it would not cause much delay, to travel along the general route of Lucas' survey, so as to make a reconnoissance of that country in advance and to send back sketches and directions as to the line of survey.

After setting Division P to work, you desired me to proceed to the mouth of the River Maligne, and commence the exploration with a view to carry the railway up that valley and down a branch of the River Brazeau which, from the Earl of Southesk's map, was supposed to have its source within a few miles of the head waters of the Maligne. Thence to the junction of the Brazeau with the North Saskatchewan, and ultimately joining Lucas' survey south of Edmonton.

Mr. Crompton was sent with me to assist in making explorations.

In your instructions of the 31st March, you informed me that one of the main objects of the survey was to fix the line of the overland telegraph, then under contract, between Fort Pelly and the entrance to the Yellow Head Pass. That the contractor would commence his work so soon as the spring should open at Fort Pelly, and it was important that the line should be defined in advance of him ; that it was desired to have the telegraph along the general route of the railway, and, when practicable, on the precise line.

You also wished me to select the most suitable line for the railway either by the Brazeau and Maligne Rivers, or on the direction of surveys previously made through the Jasper Valley to Root River, so that the telegraph construction might be proceeded with.

I was thus desired to select the most direct and favourable route for the railway between Yellow Head Pass and Fort Pelly, and to see that the telegraph line should be built as nearly as practicable on the line which will ultimately be adopted for the railway.

On the tracing of Moberly's plan which you sent, you desired me to sketch the prominent physical features of the country, and to ascertain if a better line could be projected.

From your telegrams of 30th March and 2nd April, I learned that engineers would not hereafter be required to attend to Commissariat matters, and I was directed to apply to Mr. Thomas Nixon, the purveyer for necessary provisions, equipment, men, horses, &c., for outfit, transport and supplies for the whole season.

In accordance with these instructions, I commenced at once to make preparations for the surveys. I saw Mr. Nixon on his arrival in Winnipeg on the 8th April, and on the 12th, when he had received definite instructions how to act, I made requisitions upon him for supplies for Divisions P and L, and for my small exploring party. John Brown was engaged as my Commissarat officer and guide upon your recommendation. His advice and experience were found to be of great value. Mr. Ruttan arrived on the 17th April and took charge of preparations being made for Division L. Commissariat officers were appointed to both Divisions, to act in the field under Mr. Nixon, and to assist the engineers in charge.

Mr. Nixon ascertained that no suitable provisions could be obtained in Winnipeg at that season of the year, and therefore it would be useless to start before the arrival of supplies on the opening of navigation. The first steamboat from Moorhead arrived on the 29th April, but the whole of our supplies did not come till the 18th May. Mr. Lucas arrived on the 21st April, he left his assistant and some of his party at Fort Pelly, preparing plans, etc : the rest were paid off in Winnipeg.

My own time and that of Division L was fully occupied in making tracings of previous surveys and making up the Division accounts; all were despatched to Ottawa by the 17th May.

The three parties went into camp on the 5th of May, that being the date agreed upon with the men hired, and on the 20th we all left Winnipeg, our supply trains having left in detachments before us.

In comparing my aneroids with the standard barometer at the observatory, the difference in each was only 0·02, after the journey by rail from Toronto.

I met Mr. Fuller, contractor for the telegraph, frequently before leaving Winnipeg, and arranged with him that the line would be marked out as quickly as possible.

Journey from Winnipeg to Livingstone.

On our first day's journey we passed the greater part of our supply train. They had dispersed with their loads to their houses, looking for their cattle, &c.. and we soon found that the commissariat officers had no control over the movements of the freighters, and had arranged no place of rendezvous. The result of this was that Division L had to remain for a considerable time at Totogan till supplies came up. Fortunately Division P had two months' provisions at Swan River Barracks (Livingstone), which I sent out to them on the 5th April. Mr. Lucas was thus enabled to commence his survey at once and to replenish my stock. My train consisted of five carts, a light waggon for instruments &c., three saddle horses, nine cart horses, and a party of eight, all told. With Mr. Lucas and his party we continued our journey to Livingstone. For the first week we carried oats for our horses, as the grass was short and young. From the end of May to the middle of October our horses lived entirely upon pasture.

We followed the ordinary trail through Portage La Prairie and Totogan to Fort Ellice, and from Ellice to Fort Pelly and Livingstone arriving there on the 6th June. I took note of the general features of the country between Forts Garry and Pelly.

We found the rest of Division P encamped near Livingstone.

Mr. Lucas showed me the plan and profile of his location from Mossy River to Snake Creek, and we examined the valley of Swan River with a view to getting a better crossing of Snake Creek, near its junction with Swan River, but the valley of Swan River is very rough and crooked, with bold points running into the valley. On the line, as located, the work is very light, except the crossing of a few coulees and Snake Creek. As the ground is high to the west, we resolved to adhere to the high crossing of Snake Creek. We examined the country to the west, and decided to get over the high ground by keeping in the direction of Swan River Valley for some distance.

The latitude and longitude of our initial point, near Livingstone was Lat. 51° 53′ 39″, Long. 101° 59′ 08″, calculated as nearly as possible, from Mr. Lucas' and my surveys from Shoal Lake, where my survey was connected with a known point in the Province Line of Manitoba.

I asked Mr. Lucas to compute his latitude and longitude as he proceeded, so that he might check his bearings correctly, the amount of westing being so great between Pelly and Edmonton. Mr. Lucas commenced his survey on the 7th of June.

Journey from Livingstone to Edmonton.

On the 9th of June I left Livingstone with my exploring party. The quantity of wood west of Snake Creek obliged us to go round to the south, following the trail to Pelly and Touchwood Hills with the intention of getting back to the proposed railway line on the first opportunity. I made a rough survey of our route as we proceeded, taking bearings with prismatic compass and distances by odometer, so as to fix our position and that of the railway line, using aneroids to ascertain any sudden changes of elevation.

From Pelly we followed up the Valley of the Assiniboine, over a rough and crooked road through poplar woods, passing some large lakes. On getting into more open country ten miles out, we followed a trail north-west to reach the railway line, but soon got into so much brush that we returned to the main trail, which we followed till we crossed the Assiniboine River. We then worked up to the north-west again, till we arrived within six miles of the proposed line; where we found the woods so heavy to the north and west that we had to turn to the south-east.

The country is undulating, with many small lakes and swamps, and presents no difficulties for railway construction. Where we crossed the Assiniboine, the valley is wide, and of no depth, not more than 20 feet, the river being 40 feet wide. We were travelling for a day to the south-east, before we struck the Touchwood Hill trail. In following it to the south-west, the woods appeared so close to the north, that I determined to follow the trail for the present. We passed the Little Touchwood Hills to the south of the trail.

On the 5th June we arrived at the junction of the Quill Lake road, and followed it in a north-westerly direction. We were now a long way to the south of the proposed railway line. Getting into open country at the north end of the Touchwood Hills, we again travelled in a north-westerly direction, then more to the west, and coming upon thick woods, had to bear off to the south. The country here is very level. We again struck the Quill Lake trail, and followed it to the north end of Quill Lake. I sent a messenger to Mr. Lucas, to tell him that Quill Lake and the Touchwood Hills are farther south than shewn on the maps, and that his line would not come near them. We followed the trail till we got within half-a-mile of the line. Here we made observations for latitude, and put up a mound as a guide to the telegraph contractor in delivering his material, also to mark our trail for Mr. Lucas.

From this mound, we travelled in the proposed direction of the railway, through undulating country, with groves of poplar, but soon came out upon open plains, which I took to be Buffalo Cart Plains. We crossed the plains, and passed through a very hilly country, till we struck the Carlton trail. The hills are small, and will offer no serious obstruction. Soon after, we crossed the second Carlton trail, which leads to

the upper ferry, and followed it a short distance to find wood. The contractor's train of 50 carts, with material for the telegraph construction west from the Elbow, overtook us here, and I learned that Mr. Ruttan's party was about a day behind them.

We saw a few Indian lodges near the trail, whose owners soon came up to us, and claimed a small pony which we had found on the plains north of Quill Lake, and which we gave them. I sent my cart along the trail to the ferry, and with three of my party followed our course to the South Saskatchewan.

In the first forty miles the hills increase in height and size and then bear off to the south-west. The railway will probably have to keep to the north, unless a more direct passage can be found through them to the south. The 10 miles near the Sashatchewan is nearly level and open. Having examined the banks for some distance up the river I selected a very favourable crossing for the railway, 975 feet wide. There is very little timber on this part of the South Sashatchewan, and none suitable for rafting. We then followed the direction of the river, and found our carts at the ferry. Mr. Ruttan and Division L arrived at the ferry in the evening.

As the telegraph people were the first to arrive, we had to wait till their carts were ferried over. Then all the horses were driven into the river and swam across. I told the foremen of the telegraph party that I would mark the position for the telegraph from the Elbow to the end of the Willow Hills, so that he might commence the construction at once.

Having crossed the Saskatchewan (25th June), we followed a trail to the south-west, and then struck across to our land mark on the east bank of the river. I examined the river for four miles to the south-west, and selected another crossing more on the direct line passing south through the hilly country east of the river. The width of the river here is 862 feet and the banks are about 70 high—this would make a very good crossing. We put up a mound and continued our journey on our course for the Elbow.

Between the two Saskatchewans the country is open plain, very even, and easy for railway construction. The North Saskatchewan was reached at the Elbow, and we followed the south bank to Eagle Hill Creek. This stream flows through a valley 4000 feet by 200 feet deep. I examined this valley for eight miles, and found the best crossing at the mouth of the stream. The freshet level of the Sashatchewan at this point is 10 feet higher than the present level.

From this place, on the 1st July, I sent a copy of my field plan and directions to Mr. Lucas, giving him the latitudes and longitudes of important points to guide him to the river crossings, &c.

I also put up a mound and indicated the position of the line at various places as far as the north-west end of the Willow Hills, so as to enable the telegraph contractor to commence work as soon as possible.

My journey from Eagle Hill Creek was difficult on account of the roughness of the country, the number of large coulees and the quantity of wood along the banks of the river. At one place, I found it advantageous to leave the river for eighteen miles, passing through a valley running parallel to the Saskatchewan and joining the main valley again, then following the Saskatchewan to Battle River. We had much difficulty in getting through this part of our journey, the banks of the river being thickly wooded, very rough and full of coulees. The construction of the line will therefore be costly.

On the 6th of July we crossed Battle River on a raft. The stream was 240 feet wide and seven feet deep. There are several Indian houses on the east bank which are only occupied in winter. The crossing of the river will be easy as the banks are low and the valley narrow near its junction with the Saskatchewan.

From Battle River I took a course to enable us to pass north of the Wolf and Willow Hills. This led us along the banks of Battle River and north of the Willow Hills, but a valley to the south will allow Mr. Lucas to run a more direct line. I travelled eight miles to the south-west to get into this valley, and then passed to the south of the four Blackfoot Hills. The line will ascend to this summit through a

crooked valley, bending four miles to the south, through which the work will be heavy. We passed a small camp of Crees on Battle River, heard some shooting, but did not see any of the Indians.

From the end of the four Blackfoot Hills I followed a course to lead us to the Hay Lakes and passed through some hilly, open country for fifteen miles. It then became level and undulating. We crossed a coulee 100 feet deep and 600 feet wide, and on the 10th July we encamped at a very large coulee 230 feet deep and a quarter of a mile wide. I selected the best crossing and put up a mound. Battle River appears to be only about two miles distant from our trail.

Following the same course, we passed over some high, hilly and wooded country with numerous ponds and marshes for about thirty miles, crossing a coulee ninety feet deep and 600 feet wide. The country is then open with patches of timber, level and undulating to the Beaver Hills. These hills extend in a south-westerly direction from the North Saskatchewan to a point about six miles south of our trail. Where our trail struck them they stand about 100 feet above the plains, through to the north they are considerably higher. The country here is very hilly, covered with timber and abounding in small lakes and marshes. We were detained five days in cutting our way through the hills, and were at last obliged to cut out to the south. We reached open country and arrived at the Edmonton Hay Lakes trail on the 20th of July. Here we met a French half-breed going to the plains who gave us information about the roads, &c.

Finding the country to the west much covered with woods, I decided to follow the trail into Edmonton, and having built a mound we continued our traverse along the trail.

The road to Edmonton was very rough and marshy, keeping about four miles to the west of the Beaver Hills and passing over high ground, before reaching the Saskatchewan. We arrived at Edmonton on the 23rd of July, and encamped beside Ruttan's party which arrived on the 19th; I found Mr. Ruttan making preparations for his journey to Root River with pack horses, and waiting for the arrival of his freight train.

The Hudson's Bay Company's steamboat arrived at Edmonton on the 22nd July; this was the first trip ever made by a steamer on the Saskatchewan from the Grand Rapids. It took 18 days, and from Fort Garry, 34 days, carrying 130 tons of freight,

At Edmonton we had to procure more horses and get the packing gear fitted up, pending the arrival of the provisions, &c., for our mountain journey. Mr. Hardisty gave us the use of a room in the fort, where we prepared a plan of our trail from Eagle Hill to Edmonton, laying down a projected line, tracings of which I sent to you and to Mr. Lucas.

In consequence of the large area of country covered with woods, I thought it advisable to request Mr. Nixon to send us, as quickly as possible, a further supply of provisions, for it was very doubtful that Mr. Lucus and Mr. Ruttan would connect their surveys before the winter set in. I also arranged with Mr. Hardisty to have a supply of hay cut for both parties.

Mr. Ruttan and party started for Root River on the 24th of July; his supplies did not arrive till the 5th of August. The freighters were much delayed by the quantity of rain making the roads almost impassable. It rained incessantly during our stay at Edmonton.

Journey from Edmonton to the Maligne Valley and back.

We left Edmonton on the 6th August, in company with the supply train, and assisted them in reaching Lac Ste. Anne. My party now consisted of 18 pack horses and three saddle horses, two experienced packers were also added to our strength. We took two carts to Lac Ste. Anne, the end of the cart road. I continued the traverse of our trail, now estimating the distances by time. The road was so wet and heavy that we did not reach Lac Ste. Anne till the 11th August. There we got our supplies from the freighters, flour for three months, with a little bacon, and pemmican for two

months which we obtained in exchange for bacon. I secured the services of Valad, as guide and hunter; he told me that he had accompanied a large party with horses up the River Brazeau, and down the Medicine Tent Valley, when a boy, so I thought we were fortunate in getting him.

Our first mail arrived at Lac Ste Anne from Fort Garry on the 12th, taking just one month on the journey. It returned on the following day.

On the 13th August we got our loads assorted, and started with our pack horses loaded on the trail to Jasper House. Our progress was very slow, and we found the trail bad and the country very much flooded. We had to make bridges and cut out new trails round swamps. We arrived at the River Pembina on the 16th, where we met some of Mr. Ruttan's packers. I found him encamped near the mouth of the River Lobstick. He had commenced the survey near the crossing of the River Pembina, and by so doing received his supplies, which accompanied us, before he was entirely run out. I examined the crossing of the Pembina and the valley of the Lobstick for some miles. The work will be heavy and difficult till the line leaves the banks of the Lobstick. We had to raft the Pembina, and continued our traverse on the 17th to where the trail crosses the Lobstick, which we also had to raft. Mr. Ruttan accompanied me for some distance, to examine the country in advance of his party. The trail improved a little beyond the Lobstick, but we lost some time in finding a horse which had strayed with its load in getting round one of the numerous marshes. It requires a great deal of care on the part of the drivers to prevent the horses straying in a country so heavily wooded, and where there are many delays in making the trail good. We passed Mr. Ruttan's party, which had got into more even country, and was pushing on the line to Root River. The trail led us up the south side of the Lobstick, past Chip Lake, and over high ground to the last crossing of the Lobstick, which we forded. We then crossed a high watershed between the Rivers Pembina and McLeod, and at Root River found traces of Moberley's trail party. More rain here did not improve the trail, which passes through a very marshy country.

On the 24th August we passed the east end of Moberly's line. From this point I connected my traverse with as many stations as I could conveniently reach on the survey line, and continued my notes on the topography of the country. There is some very fine large spruce on this side of the River McLeod, but no pine of any value. We rafted the McLeod on the 26th August near the crossing selected by Mr. Moberly, and followed the trail up the west bank to the north of Medicine Lodge (Bare) River, at the Grand Portage. This part of the country has been much burnt, and the trail consequently much obstructed by fallen timber. I found a very good crossing of the McLeod at the mouth of Medicine Lodge River. There is every prospect that a direct line can be found from this to Root River instead of following the McLeod so far to the north. At Medicine Lodge River the line and trail leave the McLeod, and, passing over some high ground by White Mud Lake, join the McLeod again, and follow it for 14 miles to Plum Pudding Camp. This part being so near the river, is very hilly and the country much burnt. The Rocky Mountains, covered with snow, came in sight at White Mud Lake for the first time, about 40 miles distant to the south-west. Having approached so near to the mountains without seeing them, in consequence of cloudy weather, the first view was very striking. We left the McLeod on the 31st August, and passed over a high watershed between it and the River Athabasca, 750 feet above the McLeod. The line goes round the end of this ridge at a lower level, but can still be much improved. The trail continues up the valley of the Athabasca, about four miles south of the river over a very rough sloping country, to Sandstone Creek, where we descended to the river. Following up the river, we passed over some very even terraces and open prairie at a much lower elevation than the line surveyed, to a point beyond Hardisty Creek. The view of the entrance to the Jasper Valley and Roche Myette is very grand from some of these terraces. To avoid high and wooded country at the mouth of Prairie River, we again returned to the line, forded Prairie River a mile above its mouth, and followed the trail to where the river bends to the south among the mountains. Up

this valley there is a trail to the River McLeod, but Valad assured me that it passed over high ground. There is no doubt that it is too high for the railway. From this to Fiddle River the trail and line pass over a high watershed 700 feet above the Athabasca. The ridge extends northwards along the east shore of Lac Brulé to the river, and eastwards to the mouth of Prairie River.

Three traders from Edmonton met us and exchanged some horses, which assisted us much, as some of ours were nearly useless from packing over so rough a trail. We entered the Rocky Mountains on the 4th September, forded Fiddle River at Fiddle Depôt, followed the trail along the Athabasca by the foot of Roche Myette, and past Jasper House. The river washes the base of Roche Myette for about a mile ; the face of the rock is very steep, so that the construction of the railway here would be very expensive. The Athabasca was too high to ford, so we took the old Hudson's Bay Company's trail, forded Rocky River, and traversed along the sandy and marshy flats to the south of Jasper Lake. The river takes a sudden turn to the south nearly opposite Snaring River, where there are several bold rocky points with the river at their feet. The line surveyed crosses the River Athabasca to the west side, just above those rocks. We arrived at the mouth of the Maligne on the 7th September, and connected the traverse with the line at Athabasca Depôt by rafting the river. I found the bench mark near the Depôt, and ascertained the elevation of our camp above the sea by using the two aneroids.

The River Maligne was very high and rapid, 70 feet wide and 6 feet deep, a regular mountain torrent. The largest part of the water passes under the rocks, and issues at the end of a canyon, about a mile from the Athabasca. Valad went on to explore, and reported that he could find no trail, and that he had never been in the valley before. Finding so much timber, it was necessary to cut a trail for our horses, which made our progress very slow. Food for the horses was very scarce in this valley; we therefore left our horses in the Athabasca valley, where the pasture was good, except three ponies to carry provisions, intending to take the whole train up when sufficient grass was reached. The traverse was continued on foot, and a stationary aneroid was always left at a bench-mark in charge of Mr. Crompton. I used the other aneroid on the traverse, and compared the difference on returning to the bench-marks.

There is an abrupt bench in the valley, about two miles from the mouth of the Maligne, where is the canyon before referred to. This bench is more than 400 feet above the Athabasca, or 3,750 feet above the sea. This would be overcome with difficulty by crossing the line above the Myette River, and rising with a steep grade along the south side of the Athabasca valley. About four miles from the mouth, there is another canyon, with falls; at the top of the falls the elevation is 3,980 feet. On the 11th September we reached Medicine Lake, the elevation of which is 4,521 feet above the sea. The north shore of this lake is very precipitous, with land slides, the mountains coming directly down to the water. On the south side, the shores are bold and rough, but the ascent of the mountains is more gradual. The outlet is entirely under ground for three-quarters of a mile except in very high water, the full volume of the river is not seen except within two miles of its mouth.

The trail was continued along the south bank of the Maligne beyond the lake to a point about twenty miles from the mouth, when the banks become so precipitous that we could make no more trail. Up to this, the pasture was very poor, barely sufficient to keep our three ponies alive. I therefore decided to cross to the north bank and explore the valley, as far as possible, without horses, till we should find pasture. Taking Valad and two others we continued our traverse along the north bank, leaving Mr. Crompton with an aneroid at Medicine Lake, and directing the rest of the party to examine the country for a trail further up the side of the mountains.

On the 14th September we reached Sore-foot Lake, about 33 miles from the mouth of the river, 5,134 feet above the sea, and we explored along the north shore to near the east end, 10 miles farther. The shores of the lake are very bold and rough with land slides in places, and near the east end there is a glacier reaching

within 200 feet of the lake level. The mountains beyond the east end of the lake approach each other very closely, leaving only a narrow steep gorge between them, and they are covered with perpetual snow and glaciers.

So far, we could find no trace of the Earl of Southesk's party, and I came to the conclusion, after consulting with Valad and Brown, that they must have ascended some other valley. There was no pasture to be found, and it would be impossible to get through to Edmonton without horses, I therefore decided to abandon the route and examine the valley of Rocky River. The Maligne valley is very unfit for the railway, being narrow and the banks steep. The elevation of the lake which we reached is 1,388 feet higher than the Yellow Head Pass, and, as I afterwards found, 1,534 feet higher than any point it is necessary to surmount to the east of the Yellow-Head Pass.

Accordingly, we retraced our steps and arrived at the valley of Rocky River on the 19th September. The leaves of the poplar had now changed their colour, and we had occasional showers of snow and rain.

The valley of Rocky River is wooded, and we had to cut our way over very rough hilly country, with much fallen timber. At five miles from the Athabaska there is a canyon; the elevation of the valley above the canyon is 4,000 feet, or 700 feet above the Athabasca. I continued the traverse for about fourteen miles, at which point the elevation is 4,157 feet; the river here is about the same size as at its mouth. At this point we encountered an extensive *brulê*, which extended up the river as far as we could see, and we could not make any headway through it. I took bearings up the valley and decided to return.

The entrance to Rocky River as compared with the mouth of the Caledonia valley, is too far to the north to make a more direct line than the present one down the Athabasca valley, and the elevation we reached is 411 feet above the Yellow-Head Pass, and 557 feet higher than any necessary summit towards Edmonton.

Valad and Brown both agree with me in supposing that the Earl of Southesk must either have entered the head of Rocky River valley or a branch of the Brazeau flowing around Mount Lindsay; Lord Southesk travelled across from the MacLeod to Medicine Tent valley in half a day, and ascended to the head of the valley in the afternoon of the same day (3rd September.) The mouth of Maligne River is 28 miles from the entrance to the Rocky Mountains; it is very probable that it is equally far from the head of the McLeod to the Maligne, as the ranges are nearly parallel, and the McLeod does not enter the mountains. There is an old trail from Jasper Lake to the River Brazeau; it passes to the west of Roche Jacque and goes around the head of Rocky River. This is probably the trail which Valad followed, as before referred to, when a boy, and it is likely that the Earl of Southesk struck the trail when he descended the Brazeau for a short distance, and returned again to the valley of White Goat River. Near this the Earl met with glaciers, so that the elevation must have been some 5,000 feet. The maps in his book represent the hills on the east of Medicine Tent Valley as smooth and round, while those on the west are peaked and rocky, from which it would seem that this valley is only behind the "foot hills" and not *in* the mountains. The branch of the Brazeau which you desired me to follow is well known to Valad and Brown, and they describe it as very bad, falling rapidly through canyons and high rocks. I feel sure that no practicable line can be got through in this direction.

We continued our return towards Edmonton on the 23rd September. I examined several places again, with a view to improving the line down the Athabasca. The country between the Athabasca and Prairie River is very high, and keeps its height to the north till it reaches the banks of the Athabasca. A favourable line can be got by keeping on the north side of the Athabasca from the mouth of the Myette, and crossing near Coal Creek, where the river makes a short bend to the north. The heavy rock cutting at the foot of Roche Myette would be avoided, but there will still be some points of rock at Jasper Lake and the south end of Lake Brulé.

After crossing the Athabasca, the line should follow the south bank on some even terraces, ascending from Sandstone Creek to the water shed between the Atha-

basca and McLeod, elevation 3,600 feet. The rate of ascent will be about one foot per hundred for four miles to this summit. The line should descend the valley of Medicine Lodge River to a good crossing of the McLeod, at the mouth of the valley. From this crossing to Root River, where Mr. Ruttan's survey commenced, the line will be very direct, but there may be a heavy crossing of a considerable stream, which flows into the McLeod. The rest of the ground appears to be very even.

We had a very heavy snow storm on the 2nd and 3rd of October, through which we lost a horse that had been of little use for some time. Two other pack horses had to be abandoned before we got to Lac Ste. Anne. The trail from Root River was almost worse than when we went out, a state of things caused by the traffic of Ruttan's party. I examined the crossing of the Pembina again, on the east side, and found the banks very much undermined in consequence of the softness of the sandstone and coal seams.

We arrived at Lac Ste. Anne, on the 12th October, and met some of Ruttan's men there, from whom I learned that the survey was then completed to the River Saskatchewan. Here I received your letter of the 7th July, and found an opportunity of communicating to Mr. Keefer, west of Yellow Head Pass, the result of my exploration in Maligne Valley.

I sent most of my horses and party by the cart trail to Edmonton, taking three horses and a man. I crossed over a very hilly country to White Earth Fort. Mr. Ruttan and party were at work on the banks of the Saskatchewan, three miles to the east of the crossing. I examined his plan and profile, got tracings made, returned to examine the crossing, and arrived at Edmonton on the 17th October.

The Rev. G. MacDougall was at the Fort; he told me of his meetings with the Indians, and gave me a copy of his commission from the Lieutenant-Governor. I wrote and telegraphed to you an account of my explorations, and forwarded it by our mail on the 20th October. Our horses were much pulled down, so we gave them as much time as possible to recruit, feeding them with barley.

I examined a very favourable crossing of the Saskatchewan, above the mouth of Sturgeon River, where the new Police Barrack is being built; but the line would have to be lengthened to enable it to cross there, and the Beaver Hills would be in the way.

A messenger from Mr. Lucas brought the intelligence that he had reached the large coulee, 400 miles west from Livingstone, and that he was progressing rapidly.

I sent Mr. Crompton with the mail carrier to intercept any letters for me on the incoming mail. Brown accompanied me to Lucas' Camp, and returned to take care of the weak horses at Edmonton, and other Government stores.

Journey from Edmonton to Carlton.

Taking three men, three carts and eight horses, I left Edmonton on the 24th October, passed to the south of the Beaver Hills where the line should be located, and arrived at Mr. Lucas' camp on the 30th. He was then 450 miles out from Livingston and advancing sometimes 10 miles a day. I examined his plan and profiles, which he gave to me, as it would take too much time to make tracings. On the remainder of my journey I took notes of the telegraph construction, the first sign of which was at 407 miles out, where there is a large pile of wire insulators, &c., intended for the last 100 miles. Some of the contractor's men were still engaged in putting up the line, near Fort Pitt Trail. We arrived at Battle River on the 6th November, where the contractor has built a large shanty and stables. No operator had arrived, so I was unable to telegraph from this point. Several small traders have commenced business since I passed up, and some Indian families returned from the plains were living in their winter quarters.

Over the Eagle Hills the telegraph is built some distance to the south of the railway line, in open country, and joins the line near the Elbow. There was very little snow on the ground to the west of Eagle Hill Creek; beyond that the snow seemed to increase in depth to Carleton, where we arrived on the 10th November,

Here I found that the freighter who brought out the provisions sent for in July had stored them in the Hudson's Bay Co's Fort and was unable to take them to Pitt and Victoria. I also learned that the mail from Fort Garry had not arrived, and that I had overtaken my letters and telegram which were waiting for the eastern mail. Being anxious to forward the mail as quickly as possible, I set out with it next day, leaving my camp and outfit in charge of Mr. Crompton, to follow as soon as possible. At the south Saskatchewan I found it impossible to cross, in consequence of the quantity of ice running down, till the 15th, when the crossing was strong enough to walk over; I then got the eastern mail which brought your letters directing us to locate the line west of Edmonton, but allowing me to return to Ottawa with the plans of the season's work. I dispatched my letters and telegrams by the carrier, and returned to Carleton to get the location survey commenced as quickly as possible.

At Carleton.

Mr. Nixon sent Mr. N. T. MacLeod to receive the provisions, &c., from the freighters at Pitt and Victoria. He was at Carleton and assisted me in organizing a train to carry as much provision as possible to Edmonton. He also bought what dogs could be got and some additional horses. I wrote to Messrs. Lucas and Ruttan, and sent a special messenger expecting to meet them near Battle River, desiring them to leave their parties in camp and to come to Carlton with their plans and commissariat officers.

The lines were not connected quite so soon as I calculated, and there were several delays in commencing the return journey; my message was received opposite Fort Pitt. Mr. Lucas arrived at Carleton on the 12th December, and his party came in two days after. Mr. Ruttan arrived on the 15th, having sent his party to Fort Pitt.

I was engaged during my stay at Carleton in making a plan of my examination along Moberly's line; in laying down a projected line, and in writing directions for the location survey from Edmonton to Athabasca Depôt, of which I gave copies to the two Divisions. Messrs Lucas and Ruttan were completing their plans and profiles, which they gave to me; and making preparations for their return to Edmonton.

Mr. Clark, of the Hudson's Bay Company, treated us with great hospitality, allowed us to use part of the Fort for offices, and rendered us all the assistance in his power to procure men, horses, barley, additional provisions, &c.

The train that we engaged to take the provisions to Edmonton consisted of 49 horses and 15 drivers; they left on the 21st December, in charge of Mr. N. T. MacLeod. Messrs. Lucas and Ruttan, followed them in a few days. I divided my party, horses and outfit, between the two parties, and set out for Fort Garry on the 23rd December.

Journey from Carleton to Fort Garry.

My outfit was made up of three dog trains and three men, who were returning home from Division "P." The loads were made as small as possible, with provisions for 10 days. Unfortunately, we had a severe snow-storm which made the track very heavy and obliged us to use snow-shoes the whole way to Fort Pelly. We followed the Quill Lake trail to where the line crosses it, took the line to the Assiniboine, and so on by a trail to Pelly.

From Livingstone to Mossy River we kept the line and had a very rough road. The contractor was still engaged in putting up the telegraph, and in clearing from Mossy River to Fort Garry. We had a capital trail on the lakes and on the road from Oak Point. I arrived at Fort Garry on the 20th January—twenty-nine days from Carleton.

The dog trains which I brought in with me, and four additional trains supplied by Mr. Nixon, were sent back to Edmonton with a supply of stationery and other necessaries for the two Divisions. I arrived in Ottawa on the 16th February.

Instrumental Survey made by Mr. D. E. R. Lucas, from Livingstone to the Hay Lakes near Edmonton, 504 *miles.*

I have already said that Mr. Lucas and I decided to adhere to the high crossing of Snake Creek in consequence of the roughness of the valley of Swan River and the high ground which we found to the west of the Creek. He therefore commenced to the west of the crossing, at the end of his previous location survey, and directed his survey to the North-West, following the valley of Swan River. Old Wives' Creek falls into Swan River about three miles from Snake Creek, and it was found that an easy ascent could be made to the high ground by following up Old Wives' Creek. The work will not be heavy on this part. From the point where the line leaves Old Wives' Creek to a lake ten miles out, the line surveyed is favourable; at this lake a traverse was made round the north end, but in consequence of a high ridge two miles to the west, it will be necessary to locate the line through this lake. The water can be lowered, as there is a fall of 10 or 15 feet in two miles, to a stream flowing rapidly into Swan River. About 12 miles out, the line is diverted to the north to avoid a large lake. The country is rough and full of lakes; it is covered with thick spruce and *brulé*, making it difficult to obtain a knowledge of its features. The line surveyed from the lake to the east crossing of the Assiniboine is very favourable; it can be improved by deflecting to the north, as shown on the plan, but the crossing will be wider.

From this to the west branch of the Assiniboine, the country is very easy, and the crossing the best that can be had in the vicinity.

It was found that Nut Hill lies to the south instead of the north of the Assiniboine. It extends for several miles in a north-westerly and south-easterly direction, across the line of the railway. The best way to overcome the ascent will be in the direction of the dotted blue line on the plan. The top of the hill is a level plateau, covered with alkali swamps, caused principally by beaver-dams, which can be drained. The descent on the west side is very gradual, and the work light. The line continues over the hill in a straight line to 141 miles out, except a slight deflection to the north, near the 100th mile post. The country is very favourable, and little improvement can be made in location. There is rather less timber on this part west of Nut Hill, and it is almost entirely small poplar.

From the 141st mile to 175 miles from Livingston, the country is very hilly and broken ; the line is deflected to the north to avoid high ground. It will be necessary to examine this section more in detail in advance of location. The work is not heavy, but the line can probably be much improved. There is hardly any wood here ; the country continues open to the Eagle Hills, west of the Elbow.

From the 175th mile to the crossing of the South Saskatchewan the descent will be easy, and the work not heavy. The crossing is the best that can be found in the vicinity; lower down, the valley increases very much in width and depth. About four miles up the stream there is another very good crossing, but it is too far south for the line, which is bent to the north by the range of hills east of the river.

From the South Saskatchewan to Eagle Hill Creek the line surveyed can be slightly improved as shewn on the plan. The work on this section is very light, except the approach to Eagle Hill Creek, which is along side hills, and will be heavy in places. The crossing of Eagle Hill Creek cannot be much improved.

From this Creek to 250 miles out, the line is very near the proper position. This part is much covered with woods, and being on side hills, following the North Saskatchewan, it will be necessary to have it cross-sectioned before location, as a slight deviation will make a considerable difference in the quantity of work. The work here will necessarily be heavy, and there are several large coulees which will add considerably to the amount of work.

At the 250th mile, the line leaves the river to avoid some bold points and land slides, passing through a parallel valley and joining the river again at 266 miles out. The ascent to this valley will be heavy and requires further examination. The

surveyed line beyond can be considerably improved by keeping in a lower flat to the north as shown on the plan. This part is free from woods.

From the 266th mile to Battle River the line again follows the bank of the Saskatchewan. As it is covered with timber, it can only be properly located after cross sections are made. There are several large coulees and streams, and this portion of the line will be heavy.

A better crossing of Battle River than the line surveyed can be had, as shewn by the blue line on the plan. The approaches will not be heavy.

From Battle River to 327 miles out, the line surveyed is near its proper position, but it will require straightening, as shewn on plan. The wood on this part will be light, passing along the south side of the Wolf Hills, which are composed of small sand knolls. There may be some trouble caused by drifting sand but the knolls are generally covered with small poplar.

From the 327th mile to 427 miles out, the line surveyed passes over some very rough country in places. To the south of the four Blackfoot Hills the line is very crooked and the work heavy, there are also three coulees, one of which is 220 feet below the level of the plains and 2,000 feet wide, with high ground to the west of it; with this exceptions, the rest of this portion is favorable.

I believe that these difficulties can, to a considerable extent, be avoided by passing to the south of Willow Hills and keeping in the valley of Battle River, which runs nearly parallel to the line, the coulees can then be crossed near their mouths and the line will ascend through the most westerly coulee to the level of the plains near the 427th mile.

As this deviation will be some two or three miles in places south of the surveyed line, it is impossible, with the knowledge now possessed, to shew an approximate profile of this section.

From 429th mile to near 491 miles out, at the Hay Lakes, the line surveyed is very near the proper position; it can be straightened in places, as shewn on the plan; the work is light, and can probably be made lighter on further examination. There is a good deal of brush and poplar on this part.

Mr. Lucas completed this survey on the 13th November, joining his line with Mr. Ruttan's, a few miles to the south-west of the 491st mile, or 504 miles from Snake Creek.

Instrumental Survey made by Mr. Ruttan from the Hay Lakes, near Edmonton, to connect with the surveys made from the Pacific Ocean in 1873, *to near Root River*, 141 *miles.*

As already stated, Mr. Ruttan commenced this survey at the mouth of the Lobstick River, where it joins the Pembina, and carried it on westward till he connected with Mr. Moberly's survey of 1873 near Root River. He then returned to his starting point at the mouth of the Lobstick and continued his survey eastwards till he joined Mr. Lucas' survey at the Hay Lakes.

The survey was commenced on the 11th August and the lines were joined at the Hay Lakes on the 13th November.

Commencing near the 491st mile at the Hay Lakes, the surveys made to the west were deflected too far to the south in crossing one of the branches of White Mud River. It was found necessary to make another exploratory survey from near the 491st mile, passing to the south of the western Hay Lake, crossing the White Mud branch $1\frac{1}{2}$ miles north of the first survey and terminating at the longitude of Edmonton, at the point where the location survey of this season (1876) was commenced. One of the objects of this survey was to secure the construction of the telegraph as near as possible on the proper line. Plans and profiles of this part have lately been received. The ground is rough and hilly until the White Mud is crossed, and there is a high ridge between the Hay Lakes, which flow into Battle River, and the White Mud which flows into the Saskatchewan. The grades are steep, but can be considerably improved by lengthening the line a little. The whole of this country to the west is thickly wooded, with occasional small openings of a few acres.

From the longitude of Edmonton (514 miles) to a coulee 527 miles out, the line located converges to, and nearly joins, the exploratory line. This part is very easy and the crossing of the coulee light, though 300 feet to the north the coulee is 100 feet deep and increases rapidly in width and depth.

From this point, the located line diverges to the north to reach a proposed crossing of the North Saskatchewan 534 miles out. This crossing is objectionable, as it is made at an angle of about 45° with the direction of the stream. A better crossing may perhaps be got at the mouth of a stream which joins the Saskatchewan from the south-east about ¾ of a mile above this skew crossing. It will probably be a high crossing and the approaches will be heavy.

If a satisfactory crossing is found here, the most direct line will pass to the north of White Lake, and will join the exploratory line to the south of Lake of Isles. The country is very hilly, but it is probable that a good line can be found. The exploratory line was surveyed with a view to crossing the Saskatchewan above the site of Old White Earth Fort, 553 miles out. This necessitates keeping the line close to the river for a distance of 18 miles, as the banks rise suddenly to the south, about 200 feet high, and continue to rise to the Pigeon Hills 4 or 500 feet above the river. There are numerous streams following from the Pigeon Hills, in large coulees, so that it is impossible to keep the line at a higher level. In several places the banks recede for a considerable distance from the river, leaving large flats, and approach it again in bold abrupt points. The construction on this portion would be difficult, as the line passes over several land slides, and in other parts comes so near the river that protection works would be necessary, which are objectionable in such a rapid stream.

The crossing at the Old White Earth Fort is 600 feet wide at low water, where the average depth is 7 feet. The river rises 15 feet higher and overflows the flats on each side. I examined the banks for several miles down stream and found that either the right or left bank was being washed away so that it would be necessary to put up a protection for about a quarter of a mile, to keep the stream in its channel, and to extend the bridge 2 or 300 feet over the flats. The general width of the Saskatchewan Valley is from 1 to 2 miles near the Old White Earth Fort.

The outlet of White Lake through White Lake Creek was found to be so crooked and narrow that no use could be made of it in getting away from the Saskatchewan, and it is too far north for a line passing south of White Lake.

The ascent from the Saskatchewan is overcome by following the west bank for a short distance till the high ground is reached. This approach will involve some heavy work.

From this point to the water-shed between the Saskatchewan and Pembina, 582 miles out, the line surveyed is near the proper position, and can be improved in places. It passes to the South of White Lake, Lake of Isles and Round Lake. The country is rough and hilly, and the work will occassionally be heavy. The waters of Round Lake and Lake of Isles flow through Sturgeon River into the Saskatchewan, rising within two miles of the Pembina, which flows into the Athabasca.

From this water-shed, the line makes a rapid descent to the crossing of the Pembina, following the valley of a small stream and the banks of the Pembina.

The work on the approach to the Pembina will be heavy, as it is necessary to keep well in from the water which is constantly undermining the soft sandstone and coal seams which form the banks of the river.

The crossing of the Pembina is narrow, and is the best that can be got in several miles.

The line will then follow the Pembina for about two miles, to the Lobstick; this part will be very crooked and difficult to construct, as the banks approach very near the river, and are bold and steep.

After crossing the Lobstick 586 miles out, the line ascends the valley rapidly for four miles, till the level ground is reached. The construction of this part of the line will be difficult, as the valley is very narrow and crooked. The Lobstick is a large stream and very rapid, running generally on sandstone rock. It will be necessary

to divert the stream in two places, through low points opposite, and to protect the embankments when they approach the river.

The line then leaves the Lobstick to the right, and continues in nearly a straight line to a point 601 miles out, passing a bay of Lobstick, or Chip Lake. There is a good deal of muskeg on this part of the line, but the work will be light and the grades favourable.

For the next four miles the line passes over broken country which extends to the north and south of the line. The work will be rather heavy.

From this point, 605 miles out, to 616, the line passes over several ridges, crossing the line at right angles and streams flowing into the Lobstick; there are several large muskegs, and the work will be heavy in a few places, but generally light.

From 616 miles to the last crossing of the Lobstick, 619 miles out, the line is deflected to the south to gain distance. It can be improved by keeping at a lower level, more to the north, round the shoulder of the hill to the east. The crossing is easy and the stream small.

The line still continues in a south-westerly direction for some distance, to overcome the high water-shed between the Rivers Pembina and McLeod, 624 miles out. The grades will necessarily be steep, and the work heavy in places. There are several large muskegs on this part. It is then necessary to descend rapidly to the crossing of Moose River, which flows into the McLeod. Two crossings of this kind were surveyed. The projected line shown on plan is between the two surveys. This is a small stream, but the approaches to it will be heavy.

A better line to get over the water-shed between the Pembina and MacLeod may perhaps be found in the direction of the dotted blue line, by commencing near 616 miles out, at a lower level, and bearing off to the west. Mr. Lucas is now examining this part of the country in advance of his location survey.

From the crossing of Moose River, 627 miles out, the line follows the valley of Root River, which flows into the Moose, a short distance below the crossing. It crosses Root River, and ascends a small stream flowing into it from the west to a point 632 miles out, where the survey was connected with Mr. Moberley's survey of 1873. The construction of this part will be easy. Root River is a small stream, and the approaches are light.

Notes on the Soil, Timber and Coal, between Winnipeg and the Rocky Mountains.

From daily records of the country traversed between Winnipeg and Lac Ste. Anne, west of Edmonton, I estimate that the proportion of excellent farming land is about 43 per cent.; fair land, 15 per cent.; and poor, light sandy or clay and boulders, 42 per cent.; the latter is, however, suitable for grazing purposes. The hills are generally poor soil.

Between Lac. Ste. Anne and the mountains, the soil is principally heavy clay, and, in places, sand. The frequent rains coming from the Rocky Mountains not being permitted to sink into the ground by the compactness of the clay, form large areas of muskeg. There are a few places where the soil in the valleys is fair.

The area of the land covered with timber between Livingstone and Edmonton, along the line of the Railway is about 54 per cent. Poplar is the only wood found, except a small quantity of spruce near Livingstone, and on the Beaver Hills. About the centre of this region the poplar is small, but increases in size to the east and West.

From Edmonton to the Rocky Mountains, the poplar becomes larger, but decreases in quantity, and spruce appears more frequently with pitch-pine and balsam, till the woods are entirely made up of those species.

The poplar in the North-West appears to be of better quality and closer in the grain than that found in Ontario, and resembles soft maple. It makes very good fire-wood. Very fine spruce is found to the west of Edmonton on the North Saskatchewan, and to the north-east of Carleton.

The banks of the North Saskatchewan and the Pembina rivers show large sections of coal at the railway crossings, One seam at the Pembina is about 20 feet thick. It is also found on the McLeod and at Coal Creek, near the entrance to Jasper Valley. The specimens accompanying this are from those rivers.

Conclusion.

Before closing this report, I may be allowed to say that the members of the staff and others employed, have generally performed their duties in a very satisfactory manner, and have worked faithfully to push forward the work in hand.

Mr. Lucas and his party experienced a great deal of difficulty in cutting the line through the 200 miles west of Livingstone. This portion is so much covered with wood and water that it was a most troublesome task to keep up supplies and camp outfit.

The country over which Mr. Rattan and party surveyed is almost entirely covered with woods, and muskegs are of frequent occurrence; he was obliged to pack all his supplies on horses from Lac Ste. Anne, and the trail, from the quantity of traffic, became very soft and heavy.

Messrs. Lucas and Rattan are now engaged in locating the line from the longitude of Edmonton to the summit of the Yellow Head Pass.

I have the honour to be, Sir,

Your obedient servant,

HENRY A. F. MacLEOD.

Sandford Fleming, Esq.,
Engineer-in-Chief,
Canadian Pacific Railway.

APPENDIX N.

REPORT ON EXPLORATION MADE BETWEEN LAKE NIPISSING AND RIVER PIC, LAKE SUPERIOR, IN THE YEARS 1873 AND 1874, BY W. A. AUSTIN.

SIR,—I have the honour to report that, according to your verbal instructions of the month of June, 1873, I made a combined track, micrometric and prospective survey of the country lying between the eastern end of Lake Nipissing and the High Fall of the South Branch of the Moose River, a distance of about 175 miles. The portion of the country examined lying south-east of the height of land was immediately confined to the north-eastern shores of Lake Nipissing and the Sturgeon River, the point of departure being the River Awastawasing near its discharge into the east bay of Lake Nipissing. Following the lake shore for about 20 miles and thence striking directly to the mouth of Smoky River, 28 miles from the starting point, the soil is good, about one-quarter of the distance is *brulé* and the rest generally well timbered with pine and evergreen woods and a variety of hard woods; thence to the 50th mile, along the valley of the Sturgeon River, level and well timbered, soil good. The valley of the Sturgeon River to Paul's Lake, 111 miles from starting point, offers nothing but ordinary obstructions to the construction of a line of railway. The upper part of the Sturgeon valley is generally more rocky than the lower. Along the immediate site of the line but little rock will be met, the soil being generally sandy loam.

The height of land between Lake Huron and Ottawa water is about 118 miles from the starting point. The country thence descends N. north-westwards to the head waters of the Montreal River, down the valley of which the line follows in a N. north-westerly course to the 145th mile, crossing the height of land between the Hudson Bay and St. Lawrence water near the 150th mile, continuing N. north-west to 163rd mile to a stream running into the Grassy River up the valley of which the line can go to the 173rd mile, thence to the Moose River, crossing it at the High Falls at about the 175th mile. 177 miles takes the line to the Patachicapika River, the valley of which it descends to the 191st mile from starting point, connecting with the exploratory survey of 1871 near the height of land, and after passing it, the soil becomes sandy and the character of the timber changes; the trees there being balsam, spruce, cedar, tamarac, pitch-pine, with poplar and white birch. At Fort Matagama, Hudson Bay Co. Station, about 47° 53' N. lat., they grow carrots, turnips, onions, potatoes, &c.

From the point where the exploratory survey of 1873 connects with the survey of 1871, the distance to the end of division D. of 1871 is about 30 miles. N. northwest of the point of junction, the country offers no engineering difficulties, but a site some 40 miles to the southward or near Fort Matagama would connect more directly with the survey of 1874, beginning at the narrows of Lake Missanabe, at the head waters of the main branch of the Moose River. Between Fort Matagama and Lake Missanabe the country is reported to be as level as that through which the line already runs to the northward, abounding in white birch, balsam, tamarac, with poplar, spruce and pitch-pine. The soil is generally sandy.

The survey of 1874 commences at Lake Missanabe, proceeding N. N. westward, to near the mouth of the River Pic, which discharges its waters into Lake Superior. Westward from Lake Missanabe, the line will follow up the small valley of the River Anjigame, then cross a generally flat country to about the fifteenth mile, rising to the twenty-second mile to a height of land dividing the head waters of the Moose River, east and west; thence going across the country, following the shores of lakes

and the valleys of small streams, to the thirty-seventh mile, where we get to the valley of the River Oba, proceeding downward to Lake Oba, to the northward of which the country is very flat; then taking up the valley of a river which comes into the N. W. end of Lake Oba. The line crosses the height of land between Lake Superior and Hudson's Bay, at about fifty-five miles, continuing and going to the northward of Esnagame, Mosanobik, and Mangonse Lakes, through a level country, crossing the height of land again at 59 miles from Missanabe; most of the distance up to this is surprisingly level, gravel and sand abounding, with some good soil near the rivers, where wild peas, oats, and barley, were seen growing luxuriantly, and abundance of timber—spruce, tamarac, balsam, pitch-pine, white birch, and poplar.

Descending from the sixty-ninth mile, the line would cross the River Kabinagaganing, at the seventy-first mile, (the valley of which extends some twenty miles to the southward), and at seventy-five miles leaves the valley of this river, and gets to the height of land at the eighty-eighth mile, having ascended the valley of the River Namagos, and run along part of the shore of a lake of the same name, thence following a chain of lakes, and connecting streams to the ninety-eighth mile, to the height of land, over gravelly deposits and rock formation. From this, it goes down the valley of the North White River, to the 111th mile; then passes over to the South White River, to near to foot of Lake Natamasagama, where the line crosses at the narrows, 126 miles from Missanabe Lake; thence over a rolling country to the 144th mile, to the head of a stream running into the Black River, through which valley the line would descend to 150th mile; thence following down the Black River to the 160th mile, where, meeting a small branch of the Pic River, the line descends its valley to the Pic. Nearly the whole of the country through which the line is projected, offers a fair site for a railway, and is what might be called a generally level country, comparatively but little rock existing in the immediate neighbourhood of the proposed location. Abundance of wood can be had, although much of it has been destroyed by fire. It consists of pitch pine, spruce, tamarac, white birch, balsam, cedar, and poplar. In places, the timber is small as yet. But little clay exists to the eastward of Natasagama Lake, but abounds towards the Pic River.

I am, Sir,

Your obedient servant,

W. A. AUSTIN,

Engineer in charge of Divisions D. and F.

SANDFORD FLEMING, Esq.,

Engineer-in-Chief, C. P. R.

———

APPENDIX O.

REPORT ON THE EXPLORATORY SURVEY MADE FROM THE RIVER PIC, TO THE RIVER NEPIGON, ALONG THE NORTHERN COAST OF LAKE SUPERIOR, AND ON OTHER SURVEYS MADE DURING THE YEAR 1874, BY THOMAS JEFFERSON THOMPSON.

OTTAWA, April, 1875.

SIR,—I beg to furnish the following Report upon the exploratory survey made from Pic River to Red Rock (Nepigon River,) also an instrumental survey from Lake Helen to the most southern bay of Lake Nepigon.—Division G, 1874.

General Character of Country.

The only practicable point to strike the north shore of Lake Superior, by a line from the east, b ing a small bay, the first north of Peninsula Harbour, I examined the country from the point with a view of getting a line from Pic River to the bay, a distance of about 7 miles. I found a range of mountains running along the west side of Pic River in a south-easterly direction, having an altitude of from 400 to 450 feet above Lake Superior, which rendered it impossible to pass directly east and west; but as this range decreases rapidly in altitude towards the south, a line could be obtained by passing in a south-easterly direction from Lake Superior, crossing Pic River nearer its mouth.

The formation of this district is comparatively favourable for railway construction, as although of granite, the country is not of a broken character. The gradients would be about 80 feet to the mile, and the direction of the line, with few exceptions, would be free from curves.

The formation of the country along the north shore of Lake Superior, and for a number of miles into the interior, being of an extraordinarily broken character, and most precipitous, I found it only practicable to leave the coast district for a distance of 30 miles in the total distance of 117 miles to Red Rock, (Nepigon), on account of ranges of granite mountains of a very broken character of from 400 to 1000 feet in altitude above the lake, running in every direction, with valleys intervening, extremely steep, and impracticable for railway construction. In consequence of this formation it was not possible to rise with the line to any high elevation, the only means of successfully getting a line was to keep the lowest level, and pass over the principal peninsulas or promontories, which I succeeded in doing. The only open district of country along the north shore is that extending from Nepigon River in an easterly direction to Jack Fish River, a distance of 8 miles. The entire district is almost exclusively of granite of a very compact character, with only a few inches of soil (decayed vegetable matter).

General description of the approximate Line.

In order to avoid an excess of tunnelling, a large per centage of the line is necessarily on curves of sharp grading; and having to follow in many instances the shores of bays which indent the coast, the line is 30 per cent. in excess of a direct line drawn from the bay north of Peninsula Harbour to Red Rock (Nepigon River), the direct distance being 90 miles, and by the surveyed line 117 miles. The gradients, excepting in some cases where the line passes across peninsulas, are easy.

A large number of short tunnels is necessary, which give a total of 13,300 lineal yards, equal to $7\frac{1}{2}$ miles.

There are four heavy crossings of bays, where the depth of water would necessitate heavy banks to the highest flood level, to carry trestle viaducts, the line being at a high elevation. These crossings occur at $4\frac{1}{2}$, $7\frac{1}{2}$, $17\frac{1}{2}$ and $36\frac{3}{4}$ miles on plan. The only rivers of importance to be cr ssed are:

Pic River,	span 230 feet,	depth of water at centre,		19 feet
Little Pic River	" 120 feet,	"	"	5 feet
Prairie River	" 60 feet,	"	"	4 feet
Steel River	" 100 feet,	"	"	4 feet
Black River	" 150 feet,	"	"	2 feet
Pays Plat River	" 130 feet,	"	"	6 feet

As these would be passed at a low level, the expense of bridging would be comparatively light.

Quantities.

The following are the approximate quantities in cubic yards of banks and cuttings for the distance of 117 miles from Peninsula Harbour to Red Rock, also lineal yards of tunnels:

Embankments, cubic yards, 3,443,860 per mile, equal to 29,434
Cuttings " 2,779,350 " equal to 23,755
Lineal yards of tunnel, 13,350......................equal to $7\frac{1}{2}$ miles

Lake Helen to Lake Nepigon.

The country between the northern end of Lake Helen and the most southern bay of Lake Nepigon (a distance of 15 miles) is intersected at $11\frac{3}{4}$ miles from Lake Helen, by a narrow ridge, running in an easterly and westerly direction between two lakes. The outlet from the northern lake is into Lake Nepigon, and that from the southern into Lake Helen, from thence into Lake Superior. The distance between these lakes is 1,500 feet, and the difference in their level is 47 feet. This ridge is passed by a tunnel 700 feet long, on a gradient of 64 feet to the mile.

The rise from Lake Helen to the lake at southern side of the ridge is 230 feet, in $11\frac{1}{2}$ miles. On account of the undulating character of the country it was necessary to keep in the valley of the river, which rises in the latter lake, and flows into a a second lake (situated between 8 and 10 miles on plan). The level of this lake is 220 feet above Lake Helen; from this second lake the river has a rapid descent. The lake north of the dividing ridge is 280 feet above Lake Helen, and is about two and a half miles in length; along the eastern edge of this lake the line runs to the northern extremity; from thence along the valley of the stream to Lake Nepigon, a distance of about a mile. The district selected is the only practicable one for a line connecting Lake Helen and Lake Nepigon.

General Direction of Lines.

Leaving Lake Helen, the line runs in an almost northerly direction for the first five miles; from this, running easterly about N. 45° E. to the head of the third lake, (14 miles on plan), from thence N. 40° W. for about a mile, to the head of the bay, Nepigon Lake (15 miles on plan).

The line crosses the river five times in the first eight miles from Lake Helen. The first crossing is about one-fourth of a mile from Lake Helen; the span is 50 feet, elevation 23 feet; the line from this keeping the east side of the rivers to crossing No. 2, at one mile; the span 50 feet, and elevation 35 feet; the line from this keeping the west side of the river to crossing No. 3, at $3\frac{1}{2}$ miles, the span 50 feet, elevation 55 feet; the line from this point to next crossing cuts off a bend of the river, crossing No. 4 at 5 miles, the span 50 feet, elevation 55 feet; the line keeping

on the west side of the river to the 5th crossing at $7\frac{1}{2}$ miles, the span 50 feet, elevation 10 feet; from the latter point the line skirts the two lakes up to the tunnel, at $11\frac{3}{4}$ miles; to this point the profile shows a light section in banks and cuttings. The river crossings are rather heavy, on account of being obliged to keep the line on the level of the top of the banks of the rivers, the banks being extremely steep, and their formation clay and sand. From $11\frac{3}{4}$ miles, where the line passes the summit ridge by a tunnel 750 feet in length, up to 15 miles at Nepigon Lake, the amount of work would be comparatively light, and the line throughout favourable as regards curvatures.

From 15 miles at the southern end of the bay, Nepigon Lake, where the instrumental survey terminates, I made an examination of the eastern side of the bay with the view of carrying the line on to the high ground where the surveys have already been carried out from the railway. I found that for a distance of $3\frac{1}{2}$ miles from the head of the bay, perpendicular cliffs of from five to six hundred feet above the lake skirted the bay, a footing, however, extended at the bottom of this range of cliffs, of a width varying from four hundred feet to half a mile well adapted for railway construction. After continuing along the edge of the bay for a length of five miles, the River Kouisetshtan is arrived at, flowing from the N. E. It would be necessary to follow the valley of this river for a distance of about five miles to arrive at the summit, or level tract of country, lying to the east, the height of which above Lake Nepigon is about 360 feet. The only difficulty as regards railway construction along this valley would be in obtaining practicable grading; my opinion is that seventy or eighty feet to the mile could be obtained.

I remain, Sir

Your obedient, &c.,

THOS. JEFFERSON THOMPSON.

SANDFORD FLEMING, Esq.,

Engineer in Chief,

Canadian Pacific Railway.

SUMMARY of the three Sections of 40, 40 and 37 miles in Length, North Shore of Lake Superior. (Approximate.)

No. of Section.	No. of Miles.	Description of Work.	Embankments. — Cubic Yards.	Excavations. — Cubic Yards.	Lineal Yards of Tunnel.	Banks, per mile. Average No. Cub. Yards.	Excavation, per mile. Average No. Cub. Yds.	Viaducts. No.	Viaducts. Span.	Remarks.
1	40	Banks, cuttings and tunnels...............	1,568,000	1,024,000	5,717	39,200	25,612	3	2,600	Banks taken 1 to 1 Cuttings do $\frac{1}{4}$ to 1
2	40	do ...	1,259,000	1,361,000	6,333	31,475	34,025	......	....	
3	37	do ...	616,860	394,350	1,300	16,672	10,658	.....	....	
3	117	......Totals...............	3,443,860	2,779,350	13,350	29,434	23,755	3	2,600	

75· miles of heavy work.
42· do light do
7·5 do tunnel.

The cubic quantities in embankments and tunnels combined, may be assumed to represent the total number of cubic yards necessary to be moved to construct the road, viz., embankments, 3,443,860; tunnels, 400,000; total, 3,843,860 cubic yards.

THOS. JEFF. THOMPSON.

March, 1875.

1ST SECTION of 40 miles, North Shore of Lake Superior. Summary of Quantities. (Approximate.)

No. Miles in Section.	Description of Work.	Embankments. — Cubic Yards.	Excavations. — Cubic Yards.	Lineal Yards of Tunnel.	Banks, per mile. Average No. Cubic Yards.	Excavation, per mile. Average No. Cubic Yards.	Viaducts. Height. — Feet.	Viaducts. Span. — Feet.	Remarks.
40	26 miles heavy work (rock)	1,450,000	853,000	....	39,200	21,325	....	....	Banks, 1 to 1. Cuttings, $\frac{1}{4}$ to 1·
	$10\frac{1}{2}$ miles, light surface line	118,000	....	....	....	....	....	....	
	3 large viaducts; $3\frac{1}{4}$ miles tunnel	....	171,000	5,717	....	4,287	40 55 60	1,300 100 1,200	
40	......Totals	1,568,000	1,024,000	5,717	39,200	25,612		2,600	

2ND SECTION, from 40 to 80 miles, North Shore of Lake Superior. Summary of Quantities. (Approximate.)

No. Miles in Section.	Description of Work.	Embankments. — Cubic Yards.	Excavations. — Cubic Yards.	Lineal Yards of Tunnel.	Banks, per mile. Average No. Cubic Yards.	Excavation, per mile. Average No. Cubic Yards.	Viaducts. Height. — Feet.	Viaducts. Span. — Feet.	Remarks.
40	35 miles heavy work (rock)	1,204,000	1,171,000	....	31,475	29,275	No heavy viaducts.		Cuttings, ¼ to 1. Banks, 1 to 1.
	5 miles light surface line..	55,000	....	....	....	....			
	3·6 miles tunnel	....	190,000	6,333	....	4,750			
40	......Totals	1,259,000	1,361,000	6,333	31,475	34,025			

3RD SECTION, from 80 to 117 miles, North Shore Lake Superior; Summary of of Quantities. (Approximate.)

No. Miles in Section.	Description of Work.	Embankments. — Cubic Yards.	Excavations. — Cubic Yards.	Lineal Yards of Tunnel.	Banks, per mile. Average No. Cubic Yards.	Excavation, per mile. Average No. Cubic Yards.	Viaducts. Height. — Feet.	Viaducts. Span. — Feet.	Remarks.
37	10 miles heavy work, (rock)........	292,860	355,350	. ...	....	....	....	....	Banks, 1 to 1. Cuttings, ¼ to 1.
	....	....	....	....	16,672	9,604	....	....	
	27 miles light surface work	324,000	....	....	....	....	....	....	
	Tunnels.....................	....	39,000	1,300	....	1,054	....	....	
37	........Totals	616,860	394,350	1,300	16,672	10,658	....	....	

The excess of bank over cutting arises from a long length of bank (surface line) having to be constructed from side-cutting.

APPENDIX P.

REPORT ON SURVEY OF THE PORTAGES ON THE RED RIVER ROUTE, MADE IN THE YEAR 1875; BY HENRY I. MORTIMER.

CANADIAN PACIFIC RAILWAY.
OTTAWA, 28th January, 1875.

SIR,—According to instructions received from you, I made the surveys of the different portions of the Red River route, and now lay before you the result of my work.

I left Fort Garry on the 16th of September, and proceeded by stage along the Dawson Road to the North-West Angle, a distance, of 120 miles. Regarding this portion of the route, at least 60 miles of the road is in bad repair, and will have to be lifted at least two feet above its present level. The greater part being through "muskegs" or deep swamps, it will require large side drains. Timber is not very abundant for "corduroying," so that the repairing of the road will be expensive; portions of it are through ballast hills far apart, consequently the haulage of wooden material and ballast will increase the cost of repair.

Lake of the Woods and Rainy River.

Leaving North-West Angle I took the steamer "Lady of the Lake" and proceeded across the lake and through Rainy River to the Long Sault. These waters are suitable for steamers of considerable draught. From this point, upwards, the navigation is not available for large steamers. At first it was thought that the rapids of the Long Sault and Manitou could be overcome by the steamer plying on the Lake of the Woods, but it was found that a defect in her engines would not allow of her running them.

Long Sault and Manitou.

In order to enable the steamer to overcome these rapids, it will be necessary, in my opinion, to make an excavation of about 200 feet in length in the bed rock, and to clear the channel for about 400 feet from the large boulders. I think the greatest depth of rock to be excavated would not exceed four feet, and in removing the boulders no great expense would be incurred. For the excavation, it is probable some kind of a dam would be required. The Sault rapids occur at intervals for a distance of two miles; the total fall I have estimated at about six or seven feet.

The Manitou rapids are the next impediment; they are short, falling suddenly. Unfortunately the better channel lies on the American side, but a good one may be had on the Canadian shore by excavating about 300 lineal feet of rock; this excavation in some parts may reach five feet.

It is very desirable that these works should be thoroughly complete, as this is the keystone to the uninterrupted navigation from the North-West Angle to Fort Francis, a distance of 130 miles; it can be obtained, however, only by considerable expenditure. I estimate the fall of the Manitou rapids at about six feet.

The Rainy River from this to Fort Francis is wide, very direct in its course, and of good depth.

Fort Francis Portage, No. 1.

This portage is on the Rainy River; the length is 470 feet, the difference in line of the waters 23 feet 4 inches.

Respecting Fort Francis, either of two plans may be adopted, the one tramway, the other a system of locks. It will depend upon the amount of freight and passengers expected to be carried through which ought to be used. I think the lake facilities at the Shebandowan end, even when improved, would hardly justify the expense of putting in locks. Should the traffic hereafter increase to such an extent as to make it an object to use locks, I believe it would pay, inasmuch as it would allow the steamer plying on the Rainy Lake and the Lake of the Woods to have uninterrupted navigation from the North-West Angle to Kettle Falls, a distance of 175 miles; this will depend on the amount of improvement on the east end.

Five miles above Fort Francis, at the entrance of Rainy Lake, are two rapids, the lower of 11-inch fall, the upper of 1 foot 1-inch. The Rainy Lake steamer does not run below these rapids, freight and passengers being carried in boats, which are hauled up into the lake and then transferred to the steamer. Mr. Fowler, of the Fort Francis saw-mill, informed me that he intended extending his dam further across the falls this winter; this, with a double boom from the Island to a pier in the river, would so contract the water discharge as to raise Rainy River to the level of Rainy Lake, or sufficiently to allow the passage of the steamer from Fort Francis to Kettle Falls; this distance is called forty-five miles.

Kettle Falls Portage No. 2.

This portage is 1,312 feet in length; the fall in the river being eight feet nine inches; the line is straight from one pier to the other. The first part of the channel in Lake Nameukan is exceedingly tortuous, and I have it on Mr. Peither's authority that the water route can be greatly shortened by running a mile portage from a bay of Rainy Lake into Lake Nameukan; this will do away with fifteen miles of water communication and only entail three-quarters of a mile of tramway extra; the proposed tramway as shown being one-quarter of a mile.

Nequaquon Portage, No. 3.

This portage connects Lakes Nameukan and Nequaquon, and is 19,200 feet in length or 3½ miles 240 yards. Lake Nequaquon lies 71 feet 4 inches above Lake Nameukan. I was able to get a very good line on this portage in a good direction with easy grades, in fact I believe this is the shortest and most feasible route between the two lakes. I would advise the use of locomotive power on this portage, inasmuch as it mostly lies through swamp, and it would be a matter of great difficulty to maintain a road for horses, also, it would take a much smaller staff to work an engine than the present haulage system. Proceeding up Lake Nequaquon we enter River Maligne. There is an exceedingly sharp turn immediately upon leaving the lake; a channel 400 feet in length will have to be dredged, the remainder of the river being good. This work will secure the navigation to the Island portage.

Island Portage, No. 4.

This portage is only a rock standing out in the River Maligne, the length is 250 feet and the fall is 19 feet 6 inches. Mr. Dawson's first idea was to put in such a dam as would raise the water sufficiently to render it navigable to the dam at the foot of Sturgeon Lake. The dam proved insufficient, and I do not believe it can be made so as to overcome the use of a portage below Sturgeon Lake dam, there being a fall of 30 feet between the two dams.

Maligne Portage, No. 5.

This portage, situate on the side of the River Maligne, is 5,450 feet long, or one mile 56 yards in length, the fall in the river for this distance being 22 feet. The tramway proposed runs along the edge of the river, and is very easy of construction. To substitute a canal for a tramway here would be a matter of large outlay, the surface being rock of a very hard nature.

Deux Rivières and Pine Portages, Nos. 6 *and* 7.

The length of these portages is 19 200 feet, or $3\frac{1}{2}$ miles and 240 yards. They connect Lakes Kaogosikok and Sturgeon, the fall from the former to the latter being 115 feet.

From my exploration, I found it more advisable to throw these two portages into one, than to have three transhipments, as is the case in the present route. Nothing better than what the plan shows can be obtained, as I have had the ablest assistance in exploring this portage, and no trouble has been spared to get the best posible route.

I would recommend the employment of locomotive power, as a large portion of the road would have to be trestled. There would be great difficulty in obtaining a horse road, and the grades are more than horse power could overcome.

French River.

The navigation from Lake Kaogosikok to French Lake is carried through the French River. The channel is about two miles long, very tortuous, and although navigable for a barge of 50 tons burden, I do not know whether they would be able to tow two or three boats of the same tonnage without accidents happening by collisions with the banks. A channel can be cut in lieu of this river, the length of which would be about one mile; probably about one-third of the old river bed would be available.

French Portage, No. 8.

This portage connects French Lake with River Windigoostigan, the length being 15,600 feet, or $2\frac{3}{4}$ miles 360 yards; the fall from the latter to the former is 110 feet 9 inches. I am not certain that the line I have adopted is the best one that can be obtained. My time being very limited, I was not able to try a line down by the river, but I do not think it would have been successful, as the fall in the River Windigoostigan is immediate, and drops about 80 feet in a half mile. The steep inclines at the east end may be avoided, but the line would be lengthened $1\frac{1}{2}$ miles. Navigation would then start from Lake Windigoostigan instead of from the river.

Brulé Portage, No. 9.

This connects Lakes Windigoostigan and Baril. I would propose for the working of this portage the construction of a canal from Lake Windigoostigan to the foot of the hill, connecting with a tramway worked by water power, to overcome the steep ascent to Lake Baril. The length of the canal would be 1,870 feet, and 650 feet of tramway. Lake Baril is 47 feet 2 inches above Lake Windigoostigan.

This latter I have been informed, has considerable depth of water; it is long and narrow, and at one place nearly resolves itself into two lakes. A bar of mud stretches across these narrows. Probably 600 lineal feet of channel dredging will be required here, the average depth, as near as I can estimate, being six feet.

Baril Portage, No. 10,

This portage connects Lake Baril with Lac des Mille Lacs, the difference of level between the two being two feet nine inches. Lake Baril is the highest. By raising Mille Lacs, a canal can be constructed between the two lakes, and a continuous stretch of 30 miles obtained. I do not think there would be much difficulty in draining Mile Lacs to the required height, nor would much land be laid under water, the shores being high and rocky. About two thirds of this canal would be in clay with boulders and the remaining third in rock; the excavation, however, will not be very heavy. The length of the canal would be 1400 feet.

Height of Land Portage, No, 11.

This portage is between Lac des Mille Lacs and Lake Kashabowie. There has been a channel cut from the latter lake into a small lake called "Summit Pond," altogether through marsh. Some time after being made it closed in. However, had short piles been driven into the banks they would have stood; there is plenty of timber for this purpose; this pond at present is one foot seven inches above Kashabowie. Should Mille Lacs be raised two feet nine inches, the difference of level between it and Kashabowie, will be 8 feet 4 inches.

A canal could easily be cut from Summit Pont to Mille Lacs, with one lift of the above height. At the place where the chamber is shown on the plan there would be some rock cutting, all below it would be clay, and a considerable portion next the Summit Pond would also be clay.

The length of such canal would be 4,650 feet, including the opening of the old cut.

If a tramway is constructed, the length of it will be 5,640 feet, or one mile 120 yards.

Kashabowie Portage, No. 12,

Between Lakes Kashabowie and Shebandowan.

The line adopted by Mr. Dawson is probably the best that can be obtained on this portage, so I have followed close to it. The difference of level between these lakes is 32 feet.

Mr. Dawson is of opinion that Shebandowan can be raised to the level of Kashabowie; this would lay a large tract of country under water, would also be subject to innumerable leaks, and if I am not mistaken, Mr. Murdock told me, would materially interfere with the extension of the Thunder Bay Branch. The tramway, as on plan will be 3,800 feet, or nearly three quarters mile.

The road from Thunder Bay to Shebandowan is better known to Mr. Hazlewood than to me. When I passed over it, it was covered with snow.

From my own personal observation and from conversations held with the late contractors, I have ascertained that it is not possible to convey 6 tons of freight each way daily over the road as it now stands. There is no accommodation whatever for passengers; the wharves are too small and unfit for any extended traffic.

The freight boats are in the most dilapidated condition, and I fear few of them will out-live next season's service.

The tugs upon Rainy River, Lake Nameukan, River Maligne and Sturgeon Lake are mere playthings, and are not capable of towing a barge 25 tons burden in any but the finest weather; the slightest raise of wind prevents them from putting to sea.

On Lake Nequaquon there is a good tug boat, but no large barge.

On LakeKaogosikok, there is also a good tug boat and a new large barge about 40 tons burden.

On Lake Windigoostigan there is a small but good tug boat, and a new barge of 40 tons burden is ready to be launched.

On Lake Baril there is a small tug and a large barge.

On Lac des Mille Lacs there is a good tug but no barge.

On Lake Kashabowie there is a large tug and barge.

On Lake Shebandowan there is a large tug; I am not aware whether there is a barge or not.

All of these lakes are supplied with smaller boats, but they have fallen into disuse since the introduction of the barges.

There is not one covered passenger boat on the whole route, and travellers are exposed to every inclemency of the weather.

You may judge from these facts the amount of plant that would have to be procured, and the buildings, wharves and stores which must be erected to put this line in a condition to carry 100 tons of freight with a proportionate number of passengers per day.

The maintenance of such a large fleet of tugs and barges to carry this amount of freight will be a most serious item; also the number of men required for transhipment will be very considerable.

I trust you will be able to glean from this report and the accompanying plans and profiles the information you require.

I am, Sir,

Yours respectfully

HENRY I. MORTIMER.

Sandford Fleming, Esq.

Engineer in chief.

Canadian Pacific Railway

TABLE of Lengths of Portages and Differences of Levels.

No.	Description of Portage.	Length.	Rise.	Fall.
	Fort Francis.		Ft. in.	
1	On Rainy River......	470 feet, Tramway	23 4	
	Kettle Falls.			
2	Rainy Lake to Lake Nameukan......	1,312 feet, do	8 9	
	Nequaquon.			
3	Lake Namenkan to Lake Nequaquon	3½ miles, 240 yards, Tramway......................	71 4	
	Island.			
4	River Maligne	250 feet, Tramway	19 6	
	Maligne.			
5	River Maligne	1 mile, 56 yards, Tramway..	22 0	
	Deux Rivières and Pine.			
6& 7	Sturgeon Lake to Lake Kaogosikok	3½ miles, 240 yards, Tramway................	115 0	
	French.			
8	French Lake to River Windigoostigan.....	2¾ miles, 360 yards, Tramway.......................	110 9	
	Brulé.			
9	Lake Windigoostigan to Lake Baril	2,520 feet, Canal and Tramway	47 2	
	Baril.			
10	Lake Baril to Lac des Mille Lacs	1,400 feet, Canal	....	2 9
	Height of Land.			
11	Lac des Mille Lacs to Lake Kashabowie...	4,650 feet, Canal.	11 1	
	Kashabowie.			
12	Kashabowie Lake to Lake Shebandowan..	3,800 feet.	....	32 0
	Total.............	14 miles.		

APPENDIX Q.

SCHEDULE of Quantities in Line No. 6, surveyed from the Yellow Head Pass to Bute Inlet, embracing the chief works required in bridging and grading, calculated from the profile, and estimating for solid embankments and permanent structures throughout.

YELLOW HEAD PASS TO WADDINGTON HARBOUR.

Bill of Works.

Clearing	7,750	acres
Close cutting	250	"
Grubbing	220	"
Solid rock excavation	3,335,000	c. yds.
Loose rock excavation	657,000	"
Earth excavation	26,283,000	"
Under-drains	236,000	l. feet
Bridge spans, 250 feet in clear	4	spans
do 200 do	2	"
do 150 do	8	"
do 125 do	26	"
do 100 do	62	"
do 80 do	5	"
do 60 do	11	"
do 50 do	5	"
do 40 do	21	"
Plank, B.M.,	100,000	s. feet
Line tunnels, in rock	8,200	l. feet
do in earth	2,250	"
Water tunnels, 20 feet diameter	800	"
do 8 do	640	"
do 6 do	4,050	"
Masonry, 1st class	81,850	c. yds.
do 2nd class	109,250	"
Paving	28,000	"
Rip-rap (hand-laying face of rock embankments, 75,000 cubic yards)	100,000	"
Crib-work protection, 12 feet to 15 feet high	16,000	l. feet
do do 6 feet to 10 feet high	26,000	"
Timber for beam culverts, 16 inches by 12 inches	7,250	"
do do 12 inches by 8 inches	21,300	"
do do 16 inches by 8 inches	13,550	"
do do 16 inches by 6 inches	7,100	"
Foundations for structures, Contingencies, &c.,	allow	

APPENDIX R.

NOTE ON THE ECONOMIC MINERALS, AND MINES OF BRITISH COLUMBIA, BY GEORGE M. DAWSON, ASSOCIATE R.S.M., F.G.S., OF THE GEOLOGICAL SURVEY OF CANADA.

Beyond the elevated western margin of the Great Plains, and intervening between it and the Pacific Ocean, is a region which may be characterized as one of mountains and disturbed rock formations. This runs north-westward and south-eastward, with the general trend of the coast, and is divided into two subordinate mountainous districts by an irregular belt of high plateau country running in the same direction. South of the 49th parallel, this region, from the Rocky Mountains to the Pacific, in various parts of its length, has been found to contain valuable metalliferous deposits of many kinds, and already appears to be the most important metalliferous area of the United States. In the Province of British Columbia is included over 800 miles in length of this mountain and plateau country, with an average breadth of about 400 miles. North of the 49th parallel, the Rocky Mountains are now known to extend to the Peace River, and even further northward, to near the mouth of the Mackenzie River, and to maintain throughout much the same geological character with that of their southern portion. The Purcell, Selkirk, Columbia, Cariboo, and further north the Ominica Mountains, may be taken collectively as the representatives of the Bitter Root Ranges of Idaho. The interior plateau of British Columbia represents the great basin of Utah and Nevada, but north of the southern sources of the Columbia this region is not self-contained as to its drainage, but discharges its waters to the Pacific. The Cascade or Coast Range of British Columbia, though in a general way bearing the same relation to the interior plateau country as the Sierra Nevada Mountains of California and the Cascade Mountains of Oregon, forms a system distinct from either of these. The uplift of the Sierra Nevada antedates that of the British Columbia mountains, while the Cascade Mountains of Oregon are described by Professor Leconte and others as chiefly composed of comparatively modern volcanic materials, which scarcely occur in the main ranges of the west coast of British Columbia. The parallel ranges of Vancouver and the Queen Charlotte Islands, may, as far their structure is yet known, be included with the Coast Range of the mainland.

In British Columbia, a belt of rocks, probably corresponding to the Gold Rocks of California, has already been proved to be richly auriferous, and I think it may reasonably be expected that the discovery and working of rich metalliferous deposits of other kinds will follow. Promising indications of many are already known. With a general similarity of topographical features in the disturbed belt of the west coast, a great uniformity in the lithological character of the rocks is found to follow, so that while a comparatively short distance from south-west to north-east may show considerable lithological change, great distances may be traversed from south-east to north-west and little difference noted. In British Columbia, so far as geological explorations have yet gone, they have tended to show a general resemblance of the rocks to those of the typical sections of California and the Western States, and though metalliferous veins, individually, are very inconstant as compared with rock formations, belts characterized by metalliferous deposits, and dependent on the continuance of some set of beds, are apt to be very much more constant.

In the discovery and development of her mineral riches, British Columbia labours under many disadvantages, chief among which may be mentioned the comparatively short time during which the country has been settled, with the inaccessibility of the

known mining regions and cost of labour and supplies. In addition, a great part of the country is densely forest-clad, and the surface much encumbered with glacial drift, which, though often tending to produce a more fertile soil, conceals the indications to which the prospector trusts in more southern latitudes.

All these circumstances tend to retard the development of British Columbia as a mining country. It is slowly advancing, however, and it is my opinion that, when the country is opened up and the cost of labour and supplies lessened, it will be found capable of rapid development, and may soon take a first place as the mining Province of the Dominion. It must not be omitted to state that, in one very important particular, the rocks of this part of the Pacific Coast differ from those further south—the cretaceous series changes considerably in its character, and at the same time becomes coal-bearing, furnishing the fuels mined at Nanaimo and Comox.

In the following pages I have endeavoured to give a somewhat systematic, though brief account of the mineral resources and mines of British Columbia, applying where necessary to the published Memoirs of the Geological Survey, and entering into somewhat greater detail with localities of which no published accounts are yet accessible :—

Gold.

It may, I think, be said without exaggeration, that there is scarcely a stream of any importance, in the Province of British Columbia, in which the "colour" of gold can not be found. The discovery of gold, first made known in 1858, led to the great influx of miners of that and the following year. Gold, thus the first cause attracting attention to the country, has ever since been the chief factor in its prosperity.

The annexed tabular statement shows the annual yield of gold from 1858 to the end of 1876. As no official record of the gold export has been kept, the only means of arriving at an approximate result, is to add to that actually known to have been shipped by the banks and express companies an estimated amount to represent that carried away in private hands. A great part of the gold leaving the country, unrecorded, is carried away by Chinamen, and a portion goes from the Kootenay district, without reaching Victoria.

When in Victoria last winter, with the kind assistance of Mr. C. Good, Deputy Minister of Mines, and by reference to the various banks, I revised these figures, which had been variously given by different authorities ; and, I think, though not absolutely correct, they may be accepted as being as near the truth as we are now likely to attain. Mr. Good has added to the figures in the table, from his books, the number of miners known to have been employed, and calculated the average yearly earnings of each man, giving the very high general average of $658 per annum.

TABLE from the Second Annual Report of the Minister of Mines of British Columbia, showing the actually known and estimated yield of gold; the Number of Miners employed; and the average earnings per man per year from 1858 to 1875. [To which is added the known and estimated yield of gold in 1876.]

Year.	Amount actually known to have been exported by Banks, &c.	Add one-third more, estimate of gold carried away in private hands.	Total.	Number of Miners employed.	Average yearly earnings per man.
	$	$	$		$
1858 (6 months).	390,265	130,088	520,353	3,000	173
1859	1,211,304	403,768	1,615,072	4,000	403
1860	1,671,410	557,133	2,228,543	4,400	506
1861	1,999,589	666,529	2,666,118	4,200	634
1862 / 1863	3,184,700	1,061,566	4,246,266	4,100 / 4,400	517 / 482
1864	2,801,888	933,962	3,735,850	4,400	849
1865	2,618,404	872,801	3,491,205	4,294	813
1866	1,996,580	665,526	2,662,106	2,982	893
1867	1,860,651	620,217	2,480,868	3,044	814
1868	1,779,729	593,243	2,372,972	2,390	992
1869	1,331,234	443,744	1,774,978	2,369	749
1870	1,002,717	334,239	1,336,956	2,348	569
1871	1,349,580	449,860	1,799,440	2,450	734
1872	1,208,229	402,743	1,610,972	2,400	671
1873	979,312	326,437	1,305,749	2,300	567
1874	1,383,464	461,154	1,844,618	2,868	643
1875	1,856,178	618,726	2,474,904	2,024	1,222
1876	1,339,986	446,662	1,786,648	....	....
			38,166,970		

Average number of miners employed yearly 3,220
Average earnings per man, per year $658
Total actual and estimated yield of gold, 1858 to 1875 .... $38,166,970

Adding the product of 1876, the whole amount of gold exported from the Province, in eighteen and a half years, is computed at $39,953,618, or stated in round numbers, forty millions—a very remarkable result from a colony, the total European population of which will probably not average during the same period, 10,000.

The gold yield shows a fluctuation from year to year, which is due not only to the uncertainty of the deposits worked, and number of miners employed, but depends also on climatic conditions. Thus the decrease of 1876, as compared with 1875, may be attributed in the Cariboo District to the great quantity of snow falling on the mountains during the preceding winter, and more than average rainfall of the summer; circumstances preventing the clearing of the deep claims from water till late in the season. In Cassiar the unfavourable spring prevented the miners from reaching their claims till late, and heavy floods impeded their operations during the summer.

The general distribution of alluvial gold over the Province may indicate that several different rock formations produce it in greater or less quantity, though it is only where "coarse" or "heavy" gold occurs that the original auriferous veins must be supposed to exist in the immediate vicinity of the deposit. Colours, as the finer particles of gold are called, travel far along the beds of the rapid rivers of this country before they are reduced by attrition to invisible shreds; and the northern and other systems of distribution of drift material have, no doubt, also assisted in spreading the fine gold. The gold formation proper, however, of the country, consists of a series of talcose and chloritic, blackish or greenish-grey slates or schists, which occa-

sionally become micaceous, and generally show evidence of greater metamorphism than the gold-bearing slates of California. Their precise geological horizon is not yet determined, no geological survey to that end having been made; but I am inclined to believe that they will be found to occupy a position intermediate between the Lower Cache Creek group of Mr. Selwyn's first provisional classification of the rocks of British Columbia, and the base of the overlying cretaceous or cretaceo-jurassic rocks, called in my Report for 1875* the Porphyrite series. If this be so, they are probably the geological equivalents of some of the richest auriferous rocks of California. By the denudation of the auriferous veins traversing these rocks, the gold has been concentrated in the placer deposits.

The greatest areas of these rocks appear in connection with the disturbed region lying west of the Rocky Mountain Range, known in various parts of its length as the Purcell, Selkirk, Columbia, Cariboo and Ominica Ranges. Other considerable belts of auriferous rocks, probably belonging to the same age, however, occur beyond this region, as in the vicinity of Anderson River and Boston Bar, on the Fraser, and at Leech River, Vancouver Island.

The Cariboo District, discovered in 1860, has been the most permanent and productive. The 53rd parallel of latitude passes through the centre of the district, which has been described as a mountainous region, but is rather the remnant of a great high-level plateau, with an average elevation of from 5,000 to 5,500 feet, dissected by innumerable streams which flow from it in every direction, but all eventually reach branches of the Fraser River. These streams, falling rapidly about their sources over rock, descend into great V shaped valleys, and with the lessening slope the rock becomes concealed by gravel deposits, which increase in thickness and extent till the valleys become U shaped or flat bottomed, and little swampy glades are formed, through which the stream passes with comparatively slow current. The sloping banks of the streams and river valleys are densely covered with coniferous forest, of which comparatively little has been destroyed by fire, owing to the dampness of the climate at this great altitude. The surface of the broken plateau above is often diversified by open tracts, affording good pasture in summer, and the whole country is more or less thickly covered by drift or detrital matter, concealing the greater part of the surface of the rocky substratum.

As in all new gold mining districts, the shallower placer deposits and gravels in the present stream courses first attracted attention, but with the experience of California and Australia, it was not long before the "deep diggings" were found to be by far the most profitable. Williams' and Lightning Creeks have, so far, yielded the greater part of the gold of Cariboo. They were known from the first to be rich, but have been found specially suited for deep work, in having a hard deposit of boulder clay beneath the beds of the present watercourses, which prevents the access of much of the superficial water to the workings below. By regular mining operations the rocky bottom of the valley is followed beneath 50 to 150 feet of overlying clays and gravels, the course of the ancient stream being traceable by the polished rocks of its bed, and the coarse gravel and boulders which have filled its channel. In the hollow of the rocky channel the richest "lead" of gold is usually found, but in following the rock surface laterally, side ground, rich enough to pay well, is generally discovered for a greater or less width. The old stream courses of the Cariboo district are found to have pursued very much the same directions that their present representatives follow, crossing often from side to side of the valley with different flexures, and occasionally running through below a point of drift material projecting into the modern channel, but never, I believe, actually leaving the old valley, or running across the modern drainage system, as is so often the case in the deep placers of California and Australia.

As an example of the methods employed, and extent of mining operations required to reach the deep channels, the Van Winkle Mine, on Lightning Creek, which is the most successful now in operation, may be taken. This mine is briefly

*Geological Survey, Report of Progress, 1875-76.

noticed in the Descriptive Catalogue, published in connection with the Geologica Survey's collection at the late Philadelphia Exhibition.

The claim covers about 2,050 feet in length of the valley, the deepest part of the old channel of which had been cleared out to a length of between 1,600 to 1,700 feet in October last. Much side ground, however, yet remains, and the workings sometimes attain a width of from 200 to 300 feet, in following this up as far as it can be made to pay. The claim yielded the first dividend in December, 1873, $10,000 having been expended before gold was found in the channel. It has since continued to pay handsomely, having produced in one week gold worth $15,700, and on other occasions at the weekly "clean up" sums of $14,000, $12,000, &c. At the date above mentioned the total product of gold had amounted to the large sum of $500,964.99.

In reaching the buried channel a shaft is usually sunk at the lower, or down-stream end of the claim, on the sloping side of the valley, where after having gone through a moderate depth of clay or gravel, the slaty rock of the district is reached. The shaft is then continued through this, till a depth supposed to be sufficient is attained, when a drift is started at right angles to the course of the valley, and if the the right depth has been chosen—either by rough estimation, or calculation based on that required in other neighbouring workings—the old channel is struck in such a way as to enable the subterranean water collecting in it from the whole upper part of the claim, to be pumped to the surface by the shaft. On cutting out of the slate rock, however, into the gravel, so much water is frequently met with, that the pumps are mastered, rendering necessary a cessation of work till the dryest part of the season, or the application of more powerful machinery. When the drift is not found to be at a sufficient depth to cut the bottom of the old channel, it is generally necessary to close it, and after continuing the shaft to a greater depth, to drive out again. The old channel once reached, and cleared of water, is followed up its slope, by the workings, to the upper part of the claim, and where paying side ground occurs it is also opened.

In the Van Winkle Mine, the average depth of the workings is only about 70 feet, the lowest shaft being placed 300 feet from the creek, on the opposite side of which the rock is seen to rise to the surface, forming steep cliffs. The water is raised to within 40 feet of the surface; when it is discharged into an adit 3,000 feet long, which is also used by other claims. There are two pumps, 10 inches in diameter, with wooden pipes, making about twelve four-foot strokes a minute, the power being supplied by an eighteen-foot breast wheel. This does not adequately represent the volume of water pumped, however, as the ground of this claim is partly drained by others lower in the series, in which work cannot be carried on till later in the season. The richest pay is obtained in the rock channel of the old stream, but where this is much contracted the force of the water has swept the gold away to those places where its width is increased. The harder rocks still preserve their polished and water-worn forms, but most of the slates are rotten and crumbling to a considerable depth, and in cleaning up in the bottom a thickness of one to two feet is taken out with a pick and shovel, and sent up to the surface with the overlying gravel for treatment. In the side work, as in the central channel, the greater part of the gold is found lying directly on the "bed rock" and only occasionally are paying streaks seen in the gravel a few feet above it. The side ground is worked up from the channel in successive breasts parallel to it. The average yield of the part at present worked may be stated at from two and a-half to three ounces to each set of timber; the set uncovering about thirty-five square feet of the bed rock, with a height of six feet.

The lowest layers of gravel contain many larger boulders of quartz and slaty fragments not much water-worn, which must have come down from the hill sides. The appearance being that of deposit by torrential waters to a depth of four to six feet in the channel, above which the gravel is generally better rounded, and more evenly spread, though still mixed with little clayey matter.

In consequence of the unconsolidated nature of the gravel, the pressure on the supports of the workings is excessive. The posts and caps of the timbering are in some places only a few inches apart, and the whole of the workings are lined with

complete lagging. The timber used is from one to two feet in thickness, and consists of the spruce of the country, simply barked and sawn into lengths. It costs, delivered at the mine, eight cents per running foot, all suitable sizes being taken at the same rate. The lagging, which is merely split out, four feet long, five inches wide, and two thick, costs seven dollars a hundred pieces. With every precaution, the timbers are frequently crushed by the pressure, or the uprights even forced downward into the slate. Where large boulders are removed from the sides, or "slum" is found, spruce brush requires to be extensively used behind the lagging, and in many parts of the mine the water streams from the roof like a heavy shower of rain.

The auriferous gravel is raised to the surface by buckets and rope, with friction gearing and water power.

The whole of the deep workings are annually filled with water at the time of the spring floods, and it is sometimes late in the summer or autumn before the pumps again acquire the mastery. In October last, the following companies on Lightning Creek, were driving their pumps day and night, the Van Winkle being the only mine clear of water.

Costello Claim.—Pump, 12 inches diameter, 9-foot stroke, making 10 strokes a minute.

Vulcan Claim.—Pump, 12 inches diameter, 6-foot stroke, making 18 strokes a minute.

Vancouver Claim.—Pump, 12 inches diameter, 9-foot stroke, making 10 strokes a minute (double acting.)

Van Winkle Claim.—Pumps, 10 inches diameter, 14-foot stroke, making 10 strokes a minute (two pumps.)

The quantity of water being raised at this time would therefore amount to about 13,870 gallons a minute, or 19,874,000 per diem.

In many cases the machinery and appointment of the mines is very creditable, and almost the whole expense of the mining enterprises is borne by the miners of the district themselves, without the aid of foreign capital, and with labour and materials of all kinds at exorbitant rates. Money earned in one venture is embarked in another, and the shareholders of a mine are frequently at work themselves below ground.

On Lightning Creek, about 16,000 feet of the valley may be said to be worked out, in so far as the deep channel is concerned; and though some bench claims and tributary creeks have paid well, the material on the sides of the valley is not, at present, rich enough to pay for hydraulic work. In endeavouring to "bottom" the old channel further down the valley, very great difficulties are encountered, owing to the great quantity of water met with, and the increased depth of the sinking required. There is no reason to believe, however, that the lowest part of the channel holding good pay has been reached.

The following table, supplied by Mr. James Evans, to the Minister of Mines of British Columbia, gives as correct a statement as he has been able to compile, of the amount of money taken from some of the more prominent claims on Lightning Creek, up to November 1st, 1875:—

Dutch and Siegel (now Perseverance)	$130,000
Dunbar	30,000
Discovery and Butcher	120,000
Campbell and Whitehall	200,000
South Wales	141,531
Lightning	153,962
Point	136,625
Spruce	99,908
Costello	20,476
Vulcan	56,955
Vancouver	274,190
Victoria	451,642
Van Winkle	363,983

On Williams' Creek, on which the towns of Barkerville and Richfield are situated, the chief workings have been in a space of about 2¾ miles in length. In this the deep channel has been worked through, and also as much of the side ground as would pay at the time at which the mining took place. Many of the lateral creeks and gullies here, have paid remarkably well; and the hillsides, in some places, to a height of 100 feet or more, have proved to be sufficiently rich for the hydraulic method of working, which is now extensively practised. Williams' Creek, however, will not compare with Lightning Creek in richness, its yield for 1875 being, according to Mr. Bowren's estimate, only $68,000. Baskerville, however, has a certain importance in being the centre of a number of outlying mining districts.

The "canyon" between Barkerville and Richfield divides the creek into two parts. For about half a mile above it, the ground was shallow, and has been worked open to the bed rock. Further up, deep drifting was practised in former years; hydraulic work is now carried on. Below the canyon, all the work has been deep in the old channel. Though streaks of "pay" were sometimes found after getting down about twenty feet, these were usually disregarded in early days. In the Cameron claim, however, half a mile below Barkerville, the dirt paid nearly to the surface, and was worked in stages from below after the old channel had been cleared out. The workings were about sixty feet deep at Barkerville, only thirty-five feet at the former site of Cameronton, and at the Ballarat claim,—three-fourths of a mile below Barkerville, —eighty feet. This is the lowest claim in which the old channel has been bottomed, and most of the gold obtained was light and scaly. The valley is here wide, the present stream turning abruptly to the west, while a wide, low hollow, known as Pleasant Valley, runs off in the opposite direction to Antler Creek. It is supposed by many that the main channel of the ancient watercourse turns off in this direction, but, owing to the great quantity of water and loose character of the ground, neither this nor the present valley of Williams' Creek, below the Ballarat, has yet been proved, though much money has been expended in the attempt. The Lane and Kurtz Company imported expensive machinery and erected very complete works some years ago, but have not succeeded in proving their ground, and have, for the present, abandoned the attempt. As many of the tributary streams have paid well, there is reason to believe that a part, if not the whole, of the deep channel of the lower part of Williams' Creek must be rich, notwithstanding the generally fine character of the gold in the Ballarat mine.

As already stated, Lightning and Williams' Creeks have been specially favourable ones for deep working, but even in these it has often been barely possible, with the appliances which can at present be obtained, to bottom many parts of their upper reaches, while the more difficult lower stretches of the channels have not been reached in either case. As Mr. Evans very wisely remarks: "Had many of the companies machinery of powerful capacity at first, one-third of the expense would have sufficed to prospect their ground, but unfortunately many of them were poor, struggling for existence, and coping with enormous difficulties."

Owing to the isolation of the district, and length and character of the road by which it is reached, the price of food—the whole of which is imported—and of labour is excessively high. The average rate of freight from Yale—the head of navigation on the Fraser—to Barkerville, according to Mr. Bowren, is from seven and a-half to eight cents per pound in spring, and about twelve and a-half cents in autumn; or may be said to average nine cents a pound—a heavy tax on mining machinery and other weighty articles.

The prices current of some staple articles in Cariboo, are as follows:

Flour, per lb.	8	cents.
Beans do	15	"
Bacon do	35	"
Grain, for horse feed, per lb.	7	"
Hay do	5	"

Ordinary labourers receive $5.00 per day; mechanics, from $5.00 to $7.00; Chinamen and Indians, $3.00. These prices, though a great reduction on those ruling before the construction of the waggon road, preclude the working of any but the richest deposits, which necessarily bear but a small proportion to those with a moderate or small amount of gold; and in working over the deep ground in early days much was left that would even now pay handsomely, but cannot be found or reached on account of the treacherous nature of the moved ground, filled with old timbering and water. I do not think it would be an extravagant statement to say that the quantity of gold still remaining in the part of Williams' Creek which has been worked over, is about as great as that which has already been obtained. With regard to Lightning Creek, this statement would scarcely hold, though there must be a great quantity of gold in ground of medium richness even here. To render this gold available, however, and to prove successfully the lower and more difficult parts of the valleys, greater and more exact engineering knowledge, better and larger machinery, and above all, cheaper labour and supplies, dependent on greater facilities of transport, are required.

As an illustration of what might be done in this way, it may be mentioned that it is already suggested, that by cutting a flume to Antler Creek—part of which would require to be a tunnel—free drainage of the whole upper part of Williams' Creek would be obtained; enabling the valley from its sources to the flume level, with all its old workings, and the great depth of tailings holding more or less gold, which have accumulated, to be completely stripped by extensive hydraulic works.

So far, mention has been made of only Williams' and Lightning Creeks, but there are many other localities in the Cariboo district which have yielded much gold in surface work or shallow diggings, which it is believed by those best able to form an opinion, would prove rich in their deep ground, if properly explored. Owing, however, to the great cost of prospecting, and of suitable machinery, this has not yet been done. Antler, Cunningham, Jack of Clubs, and Willow River, are supposed to be especially promising, and attempts are now being made to bottom some of them. Mr. Bowren states, however, that the Nason Company have already spent $30,000 on their claim on the first-named stream, without having been able to test their ground.

In most gold-bearing countries the placer mines, though often rich, have eventually led to the mining and treatment of the auriferous quartz from which the alluvial gold has been derived. No success has yet, however, been obtained in quartz-mining in British Columbia, and very little attention has been paid to it, the placers having absorbed the mining energy of the country. Though much of the gold accumulated in the beds of the old streams of Cariboo may have been derived from veins too small to work individually, it seems scarcely to admit of doubt, that in a region where so large a quantity of gold has been obtained within so small an area, rich lodes will be discovered and worked. Indeed, notwithstanding the want of attention to these deposits, and the very difficult nature of the country to prospect, several are already known, which in other parts of the world, might justify extensive mining operations. Some of these have been traced with considerable and well-maintained width for several miles. The gold occurs, as is usual, in association with iron pyrites, but also often with considerable quantities of galena, through crystalline masses of which the precious metal is sometimes strung. Not a single stamp-mill is in operation, however, in Cariboo or any other part of British Columbia, a small test battery which is at Richfield having been run for a few days only at a time, on one or two occasions, by men unexperienced in quartz milling. The remarks made in connection with the placer mines, as to the cost of labour and provisions, apply in this connection with even greater force. Vein mining, once initiated, will, I believe, rapidly develope, giving to the district a permanent character which it does not now possess, and indirectly tending to cheapen labour, by giving employment summer and winter.

Of the districts of Kootenay, Omineca, and the new Cassiar region, I know nothing personally, nor have they ever been visited by any member of the geological staff. Situated on the same belt of auriferous rocks, they, no doubt, in the main features of their deposits, resemble those of Cariboo. There are also several other localities on

the line of the main development of the auriferous rocks, which have, from time to time, attracted attention, and yielded more or less gold; but from their limited character, poor pay, or depth of cover, they have been abandoned or allowed to fall into the hands of Chinamen. The greater part of the gold range, especially toward the north, is very densely timbered and covered with moss, peaty swamps and tangled vegetation, rendering its examination very difficult, and the discovery of the rich spots, a matter requiring time and labour; in this respect it differs altogether from the bare slopes of California. It is to be remarked, however, that when altered conditions render deposits of the lower grades remunerative, that the recognized areas of all the gold-fields will be very much extended, and that many of those which have now fallen out of notice, will again spring into importance.

The yield from Kootenay, for 1875, is stated by the Minister of Mines to have been about $41,000; 40 White and 50 Chinese miners being employed. The district has produced, I believe, about the same amount in 1876.

The Omineca district has certainly not proved as rich as it was at one time supposed to be, and has been in great part abandoned for the new field of Cassiar. In 1875, the total population was 68; the estimated gold product, $32,000. The number of miners in 1876 was still smaller. I have spoken to several men who have left this district but who still appear favourably impressed with its prospects. The transport of supplies from Yale costs 18 cents a pound, causing provisions of all sorts to be so dear that a miner cannot afford to stay, unless he has a rich paying claim. Extensive prospecting is quite out of the question as a private enterprise, and, in consequence, great areas remain yet untried. Mr. Page, late government agent in the district, believes the Findlay Branch to be specially worthy of examination.

A sample of quartz, with some galena, obtained on a stream running into Manson Creek, 30 miles from Dunkeld. which was transmitted by Mr. Hamilton, of Stuart's Lake, proved, on examination by Mr. Hoffmann, in the laboratory of the survey, to contain $11.57 of silver to the ton, with traces of gold, the silver being contained in the galena, which is confined to a small portion of the vein, and must be highly argentiferous. Other veins reported in this district have not been examined.

Nuggets and pellets of native silver, generally worn and rounded, but occasionally rough, and seeming as though recently freed from the matrix, have been found in considerable abundance in some streams during gold-washing operations. They are specially noticeable in Vital Creek, I believe, but have attracted little attention, and have not been traced to their source. On analysis, the silver is found to contain a few per cent. of mercury in combination, and it may therefore be more correctly named a native amalgam.

The Cassiar district is the latest, and most northern discovery on the auriferous belt of British Columbia, being situated about north latitude 59°, and separated from Omineca by over three hundred miles, unknown geographically, and scarcely, if at all, prospected. Gold has long been known on the lower part of the River Stickene, by which Cassiar is approached from the coast; but it occurs there in light scaly particles, like those obtained on many of the bars of the Fraser. The rich deposits, lately discovered, lie on the sources of the River Dease and about Dease Lake, the upper end of the latter being separated by only a few miles of low country from a part of the Stickene. The Dease empties into the Mackenzie, and thus passes to the Arctic Sea. The discovery of this district is due to Mr. Thibert, and a companion, who reached it from the east in 1872, after three years spent in trapping and prospecting. Mr. Good states, in the report already referred to, that the area of the Cassiar gold-field, as at present developed, comprises a tract of country of at least three hundred square miles. The number of miners employed during the summer of 1875 was over 800, and the gold obtained is estimated at a little less than a million of dollars. Dease and McDame Creeks, the two most important in the district, are about one hundred miles apart, while discoveries have been pushed northward and eastward on river systems connected with the Dease to a distance estimated at 370 miles, in a region which probably lies beyond the Province of British Columbia. A

promising quartz vein, containing gold, silver and copper, has been discovered on McDame Creek, and a lode of argentiferous galena on the River Francis or Deloire.

The Cassiar mines are worked under enormous disadvantages, situated in an almost arctic climate, where the soil is permanently frozen at a small depth below the surface on the shady sides of the valleys, with a short season during which the water courses are liable to floods, disastrous to the mines; reached after a sea voyage from Victoria, by the River Stickene, only a part of which is navigable even under the most favourable circumstances, and with supplies of all sorts at famine prices, only the highly auriferous character of some parts of the district continues to render it attractive. It is scarcely likely that any improvement in the means of communication in the more settled portions of British Columbia will materially affect Cassiar, but the existence of its rich deposits is important as showing the continuity of the auriferous belt of the country; and if rich metalliferous veins can be proved to exist, on which more permanent mining may be carried on, Cassiar may yet rise on its own merits to be an important mining district, drawing its supplies by improved trails, or by a road, from the central portions of the Province. Beef cattle are even now driven overland from the Lower Fraser to Cassiar.

It will be unnecessary to refer at any length to the River Fraser gold deposits, the first to attract notice, but rich in only a small portion of their extent. It is estimated by Mr. Good, that about $50,000 worth of gold was produced on the Fraser during 1875, the mining being chiefly in the hands of Chinamen and Indians. The gold occurs along the whole course of the Fraser, irrespective of the formation over which the river may pass. Heavy gold has been chiefly found from a few miles below Boston Bar to Siska Flat, near Lytton, and on the Thompson, near Nicommen. It is no doubt derived from the rocks of the neighbourhood. The richest deposits are supposed to be worked out, though it is quite probable that many of the benches would pay for hydraulic working properly appointed.

In Vancouver Island, the Leech River District, situated about twenty miles from Victoria, attracted much attention at one time, and yielded a considerable quantity of gold in a small area. The total product has been estimated at $100,000. It is interesting in having been discovered by a government prospecting expedition fitted out for the purpose. The rocks I believe to be of the same age as those of the other gold regions, and if this be so it proves the persistent auriferous character of this horizon over a great area, embracing, it may be said, the whole of British Columbia. Gold in small quantities has also been found in other parts of Vancouver Island, but, owing to the impenetrable character of the forests, comparatively little is known of any part of its interior.

Coal and Lignite Bearing Formations.

A line drawn on the ninety-seventh meridian separates pretty exactly the coal-bearing formations of America into two classes. West of Eastern Nebraska, the carboniferous formation, properly so called, which yields the coals of Nova Scotia and the States east of the Mississippi, ceases to be productive. The shales and sandstones associated with the coals of the east are gradually replaced by limestones, which underlie the great plains, and, though the formation does not preserve its purely calcareous nature on the west coast, it still shows little tendency to resume its coal-bearing character. The coals and lignites of the west are found at various horizons in the secondary and tertiary rocks, which in the eastern regions are developed on a comparatively small scale, and are not coal-producing. Valuable coal deposits may, however, yet be found in the carboniferous formation proper of the far west, and where, as on some parts of the west coast, the calcareous rocks of this age are largely replaced by argillaceous and arenaceous beds, the probability of the discovery of coal is greatest. I believe, indeed, that, in a few localities in Nevada, coal shales, used to some extent as fuel in the absence of better, are found in rocks supposed to be of this age. The discovery of certain fossils last summer in the limestones of the Lower Cache Creek Group, enable these,

and probably also the associated quartzites and other rocks, to be correlated with this period, and it is worthy of mention that black shales, with a considerable percentage of anthracitic carbon, occur in connection with these in several places, and may yet be found, in some part of their extension, to become of economic value. Mr. Richardson has also found small fragments of true anthracite in rocks which are very probably of this age, on Cowitchen Bay, and inland, seams of anthracite, probably inconsiderable in thickness, of which several specimens have been brought out, but with regard to which nothing certain is yet known, are reported to exist, and seem to deserve examination.

The formations known to produce fuel of economic value in British Columbia, may be classed in three divisions, as follows:—1. *Lower Cretaceous or Cretaceo-jurassic rocks of Queen Charlotte Islands, etc., holding anthracite; 2. Cretaceous rocks of Vancouver Island, etc., with bituminous coal; 3. Tertiary rocks, with bituminous coal and lignite.*

The first-named series of rocks is only as yet known to hold coal on the Queen Charlotte Islands, where, at a place named Cowgitz, the Queen Charlotte Coal Mining Company, formed by some gentlemen in Victoria, began mining operations some years ago, but eventually abandoned them on account of the irregularity of the deposits. This locality has been examined and reported on by Mr. Richardson,* who made a short visit to the island for that purpose. The best seam had a thickness of a little over six feet for a distance of about sixty or seventy feet, but became mixed with shale and limestone, and was eventually lost. A second bed of good anthracite, two feet five inches in thickness, also occurs, and other thin seams. A man who was afterwards employed by the company to undertake explorations on their behalf, traced the continuations of the beds for three or four miles, and reports having observed outcrops of coal seams on most of the streams he crossed. It is also reported by the Indians that a well-marked coal seam occurs about fourteen miles from the original locality in a south-easterly direction, on the south side of Skidegate Channel, which would give an extent of at least twenty miles to this area of the coal-bearing rocks in that direction; the facts indicating, as Mr. Richardson remarks, the general permanence and continuity of the coal beds, however variable they may be in detail. Between Cowgitz and Masset, on the north end of the island, from which samples of anthracite coal have also been brought, a level country is reported to exist, below which Mr. Richardson supposes the coal formation may also extend, and should it be found to do so, the total length of the coal area on the Queen Charlotte Islands would be little short of one hundred miles.

In composition the anthracite of the Queen Charlotte Islands, compares favourably with that from Pennsylvania. The following analyses by Dr. Harrington†, were from samples collected by Mr. Richardson; No. 1 being from the six-foot seam; No. 2 from the so-called three-foot seam (2 ft. 5 in.) :—

	I.	II.
Water	1·60	1·89
Volatile combustible matter	5·02	4·77
Fixed Carbon	83·09	85·76
Sulphur	1·53	0·89
Ash	8·76	6·69
	100·00	100·00

By the discovery of characteristic fossils, we are now enabled to place a series of rocks occurring on the east side of Tatlayaco Lake, and also those of the Jackass Mountain group of Mr. Selwyn's report already referred to, on, or very near, the geological horizon of the coal-bearing series of the Queen Charlotte Islands. These rocks are extensively developed on the eastern flanks of the Coast Range, near the

*Report of Progress, Geological Survey, 1872-73, p. 56.

†Report of Progress. Geological Survey, 1872-1873, p. 81.

head waters of both branches of the Homathco, and probably occur in considerable force, with a similar relation to this axis of disturbance, through its length, as the explorations of last summer have led to the discovery of rocks near the same horizon, on the Salmon River, in latitude 52° 50′. To what extent this series may continue to hold coal on the mainland, or whether it entirely ceases to do so, remains as a matter for future enquiry, though it may be stated here, that on Tatlayaco Lake some carbonaceous matter, with broken fragments of plants, occurs in connection with shaly beds. The rocks of this group well deserve a more careful and extended examination ; and for the purpose of ascertaining their thickness and real character the coast sections of the Queen Charlotte Islands are probably best adapted, and once worked up, would serve as a standard of comparison for other and less accessible regions.

The rocks of the second class are best represented in the coal fields of Nanaimo and Comox, on Vancouver Island, and are now well ascertained to be of Cretaceous age. Coal is said to have been discovered at Nanaimo by the Indians about twenty-two years ago. Through them the Hudson Bay Company heard of its existence, and subsequently began to work it. In 1861 they sold their mine, now known as the Vancouver Company's Colliery, to an English company.

The Comox and Nanaimo areas have been thoroughly examined by Mr. Richardson. They are described in his reports for 1871–72, 1872–73, 1873–74, and will be more completely treated of in a forthcoming report.

Quoting from the report of 1871-72, the coal measures are described as resting in a "narrow trough, which may be said to extend to the vicinity of Cape Mudge on the north-west, and to approach to within fifteen miles of Victoria on the south-east, with a length of about 130 miles." The surface of the country is generally rolling, with no elevations rising to a greater height than 800 feet, and in some places is comparatively level. The rocks accompanying the coals, are sandstones, conglomerates, and slates, and are often false-bedded on a large scale. They hold abundance of fossil plants and marine shells in some places, and in appearance and degree of metamorphism much resemble the true carboniferous rocks of some parts of the east coast.

On the Nanaimo area, there are three companies now at work, the mines being known respectively as the Vancouver, Wellington, and Harewood. The two first carry their coal to the wharf by short railways on which locomotives are used; the last-named is provided with an aërial wire tramway. Two seams are worked in the Vancouver Company's Mine, respectively six feet, and three feet in thickness, and probably averaging together eight feet of clean coal. The seams were lately lost at a fault, but have been recovered at a slightly increased depth by boring, the thickness of the upper seam being reported at nine feet in the bore-hole. The coal bed worked by the Wellington Company, at Departure Bay, averages nine feet six inches, while a second seam stated to be six feet thick, is known, but is not used. The seam at the Harewood Mine, averages five to six feet in thickness, and three and a half feet below it, is a seam three feet thick. It is difficult to ascertain the precise equivalency of the different beds, but Mr. Richardson is of opinion, that those of the Vancouver and Wellington areas represent each other.

The coal is worked, I believe, on the pillar and stall system, though parts of the seams have been so steeply inclined as to require stoping. The miners employed are Whites, Chinese and Indians. Mr. Good states the number of each, for the year 1875, to be as follows:—Whites, 396; Chinese, 176; Indians, 51; giving a total of 623. The wages earned by the Whites vary from $2.00 to $5.00 a day; by the Chinese and Indians, from $1.00 to $1.50. The total out-put of coal for 1875 is given at 110,145 tons, being an increase of 28,597 tons 12 cwt over that of 1874. During 1876 the output is stated to have been 140,087 tons, showing an increase of 29,942 tons over 1875. At the mines the coal sells at $5.00 to $6.00 a ton; at San Francisco it commands about $10.00.

The Comox area has probably a greater extent of productive measures, and may eventually become more important than the Nanaimo, and at the present time a com-

pany are in a position to ship coal there, having constructed a railway and the necessary wharves and works. Mr. Richardson gives a number of carefully measured sections of the productive division of the Comox area, * showing their character along various parts of a line, which, following the direction of the outcrop of the beds is about 30 miles in length. On Brown's River, furthest north, almost the entire width of the productive measures is exposed in a thickness of 739 feet 6 inches of beds. In this section 9 coal seams occur, with an aggregate thickness of 16 feet 3 inches, the thickest bed being the lowest in the series, and averaging 7 feet. In a section of 122 feet at the Union mine, 10 coal seams, with an aggregate thickness of 29 feet 3 inches occur, the thickest seam being 10 feet. This section represents only a small part of the productive division. In a third section, on Trent River, again embracing nearly the entire thickness of the productive measures, 13 seams are found, with an aggregate thickness of only 18 feet 1 inch, the thickest bed being 3 feet 8 inches. On the area of the Baynes Sound Company, in 220 feet 10 inches of measures, two seams 6 feet, and 5 feet 10 inches respectively occur.

Mr. Richardson † estimates the extent of country underlaid by the productive measures, at 300 square miles, without taking into consideration that which may lie beyond the shore; and computing the total thickness of workable coal in the Union Company's property, at a little over 25 feet, calculates the quantity of coal underlying the surface at 25,000 tons per acre, or 16,000,000 per square mile for this part of the region.

It will be seen from the outlines of sections given above, that the productive coal rocks of Comox, though throughout preserving their carboniferous character, probably vary considerably in the number of seams contained, and even more widely in the thickness of the individual seams in different parts of their extent. This variability appears to be equally found in all parts of the Vancouver coal-fields which have been examined, and contrasts with the great comparative regularity of those of the palæozoic carboniferous formation. In the working of these beds, the next most important exploration, after the mere definition of the coal-basins, will be the proving of the seams from point to point by boring operations. To this end the diamond drill has already been used to good purpose.

In quality, the Vancouver coals are found superior for all practical purposes, to any worked on the Pacific coast, and command, in consequence, a higher price. The comparatively limited scale on which the workings are at present carried on, is owing to the small demand for local purposes, and the high duty imposed on the coal entering San Francisco, the chief foreign market. In spite of this, however, Nanaimo coal is used on the western section of the Central Pacific Railway.

Dr. Harrington has given the following statement of the average composition of the coals of Vancouver Island, as deduced from his analyses: ‡

	Slow coking.	Fast coking.
Water	1·47	1·47
Volatile combustible matter	28·19	32·69
Fixed carbon	64·05	59·55
Ash	6·29	6·29
	100·00	100·00

In a sample from the Union Mine, Comox, the percentage of ash is only 2·83.

Nanaimo and Comox are not the only known coal fields of Vancouver Island. Coal occurs, and was worked at one time by the Hudson Bay Company, near Fort Rupert, on the north-eastern coast of the island. A low, flat country is reported to

*Report of Progress, Geological Survey, 1872-73, p. 85 *et seq.*

†Report of Progress, Geological Survey, 1871-72, p. 80.

‡ Report of Progress, Geological Survey of Canada, 1872-3, p. 79.

stretch across from here to Quatseno Sound on the west coast, where the coal rocks are again known. Some examination of the latter locality was made at one time for an English company, who had acquired property there, by Mr. Landall. Mr. R. B. Brown, the botanist, also visited the region in 1866, and writes regarding it: "My opinion is decided that the Koskemo (Quatseno) coal field is the best yet discovered in Vancouver Island, though unopened out, not only on account of the superior quality of the coal, but the ready accessibility of the mines from the Pacific, without the tedious inland navigation requisite for reaching the mines on the eastern seaboard of the island." The main seam is stated by Mr. Landall to be four feet six inches in thickness, and the quality of the coals, as shown by his analyses, is good. He estimates the coal of the part of the Quatseno basin he examined, making allowance for faults, &c., at 33,600,000 tons.

Mr. Richardson also describes the occurrence of rocks of the coal series at the head of Alberni Canal, opening into Barclay Sound on the west coast. Specimens of coal have been procured there, but the mode of its occurrence is not known; neither this locality, nor those on the northern part of the island, having yet been examined by the Geological Survey.

The interior of Vancouver Island being comparatively unknown, even in regard to its main topographical features, it is not improbable that a geological examination may bring to light coal areas, which may be extensive and important, in the valleys of the interior. A considerable part of the crumpling and metamorphism of the older rocks is of post-cretaceous date, a fact which renders it quite possible that outlyers of the coal rocks may be folded into more synclinals than those already known along the coast line.

The question of the possible occurrence of coal-bearing rocks of the age of those of Vancouver Island on the mainland of British Columbia, is one on which little can be said. The equivalents of these rocks have not yet been distinctly recognized, nor is it known whether it will eventually be possible to separate them by any well marked line, from the lower rocks of the Queen Charlotte Islands, and their representatives on the mainland.

The coast sections of Vancouver and the Queen Charlotte Islands will probably afford the means of determining the relations of the two series.

The tertiary rocks of British Columbia appear to hold both coal and lignite, though this series is better known in its extension southwards in Washington Territory, than within the limits of the Province. At Bellingham Bay, and at Seattle, on Puget Sound, it has been worked for a number of years, and the mines of the latter locality are now in a flourishing state, and ship large quantities of coal to San Francisco, which, though inferior to that of Nanaimo, can compete with it, owing to the protective duty. The Seattle coal seams are said to be five in number, and to vary from four to twelve feet in thickness. In quality, they may be considered equal to the better class of lignites from the western plains and Rocky Mountain region, which are found to be sufficiently good for steam raising and most ordinary purposes, but compare unfavourably with true coals. Mr. Macfarlane, in his work on coals, gives the following analysis of that of Seattle:—

Water	11·60
Volatile combustible matter	35·49
Fixed Carbon	45·97
Ash	6·44

The tertiary rocks of Puget Sound have never been thoroughly examined, but it is believed by those who have studied them for the purpose of tracing the seams of coal, that, leaving out of consideration minor irregularities, they lie in a wide trough between the Olympic and Cascade Mountains. In the central part of this trough, and strategraphically the upper part of the series, the fuels are lignites; lower down in the series these are replaced by fuels more closely resembling coals, and on the outer edges of the trough by coals in some places so much altered that they have been called anthracites. It is possible that all these tertiary rocks rest unconformably

on the cretaceous, and are separated from it by a lapse of time during which folding of the older beds and elevation of mountains took place; but it is not impossible that in some places there may be a more or less complete series of passage beds between cretaceous and tertiary, as occurs on the eastern slopes of the Rocky Mountains; or that there may even be two series of tertiary rocks separated by an unconformity as some observations would appear to indicate.

The tertiary coal measures of Puget Sound and Bellingham Bay are continuous north of the 49th parallel, and must underlie nearly 1,000 square miles of the low country about the estuary of the Fraser and in the lower part of its valley. Lignite has been found in connection with these rocks at Burrard Inlet and other localities, and specimens of a fuel resembling true bituminous coal (and coking on the application of heat) have been obtained near the Fraser above New Westminster. The remarkably good specimen of coal from the River Chilliwack, of which an analysis by Dr. Harrington is given on page 99 of the Geological Survey Report for 1873-74, is probably from this series. The seams, so far as known, are quite thin, but the low country underlaid by the formation is deeply covered with drift and alluvium, and exposures are few. Mr. Richardson has made a slight examination of the coast sections on the shores of Burrard Inlet, but the rest of this district has not been worked out. A geological examination, embracing all the known outcrops, would probably have to be supplemented by boring operations in well-chosen localities before the value of the coals and lignites of these rocks can be ascertained.

Tertiary rocks holding lignite, are found fringing other parts of the coast in greater or less width. They have been seen near Sooke, and at various places on the south-west coast of Vancouver Island. They also occur at Clallam Bay on the south side of the Strait of Fuca, in Washington Territory. None of these localities have been particularly examined, nor are they likely to be of importance in view of the accessibility of the superior coals of the cretaceous, unless in some place, thick beds of lignite somewhat resembling bituminous coal in its properties, like that of Seattle, should be found to occur. If such beds should prove to exist they may acquire some importance from their less disturbed and more easily workable character.

Lignite and coal formations of tertiary age are known to cover great tracts of the interior of British Columbia, and it can now be shown, from several sections examined last summer, that in most places the horizontal, or slightly-inclined basaltic, and other igneous flows of the interior plateau, are attached to, and form the latest rocks of the lignite-bearing tertiary. Trom this fact, and the known relations of the beds in a number of localities, it is highly probable that sedimentary tertiary deposits underlie a great part of the area showing only the later igneous rocks at the surface and wherever extensive exposures of these tertiary deposits occur, more or less coal or lignite has been found in association with them.

In the Nicola Valley, near the junction of the Coldwater, the occurrence of coal has been known for some years, and on analysis it has proved to be a bituminous coal of very high class. The average of two determinations by Dr. Harrington gives the following result:

Volatile combustible matter and moisture	36·065
Fixed carbon	61·290
Ash	2·645
	100·000

I made a cursory examination of this locality last November, the result of which may deserve somewhat detailed mention, not only on account of the probable importance of the series, but as no other account of it has yet appeared. The chief exposure of the coal is in the west bank of the Clearwater river, which joins the Nicola from the South, and down which one of the proposed lines for the Canadian Pacific Railway passes, in its way from Hope to Kamloops. The original opening on the coal was almost in the bed of the river, and is now quite filled up. A second small opening has, however, been made a little higher up the bank, and here a

thickness of six feet of coal was exposed at the time of my visit, the base of the bed not being visible at this depth. It holds one shaly parting of from one-half to one-fourth of an inch thick, but otherwise appears to be of good quality throughout, though rusty in the joints and tender from exposure to the weather. The coal bed passes below a considerable thickness of pale yellowish, rather coarse-grained, soft sandstone, which crumbles under the weather and appears to dip here about north, at an angle of 10° to 15°. In a second exposure, at the distance of about a mile, in a ravine in the south bank of the Nicola, similar sandstones occur, associated with blackish shales and again holding coal. This bed, like that of the last locality, has been worked to a small extent, by the blacksmiths of the neighbourhood. It is of similar quality to the last, but the overlying beds have fallen down on the outcrop, and the thickness of the seam could not be determined, though it must be, at least, several feet. Unless extensive slides have taken place, there must also be one or more smaller seams in addition to that which has been worked. Beyond the Coldwater Valley to the east, on the Nicola, older crystalline rocks appear, cutting out the coal measures; but westward, the coals with associated sandstone pass beneath a great thickness of the rocks of the tertiary volcanic series, dipping on the whole at low angles to the south-west. In following the Nicola Valley westward, the volcanic rocks are found to form the mass of the hills which rise steeply on either side, but the sandstones of the coal formation are seen to rise from time to time in the lower parts of the slopes. They show in some places an interbedding with flows of igneous rock. At the junction of the two classes of deposits, and in other instances, the sandstones are observed to graduate more or less completely into tuffs, and other similar rocks formed of the finer volcanic debris. The sandstones and overlying series are folded together into a number of anticlinals and synclinals, of which the axis have a general north-west and south-east course. Westward, however, the sandstones rise to smaller heights above the stream, while the overlying igneous rocks are shown in greater thickness, in hills of increasing height. The last outcrop of sandstone is about six miles from the junction of the Nicola with the Thompson, after which, the undulations, not being sufficiently great to bring the sandstones to the surface, only the igneous rocks appear, and form, a few miles below Spence's Bridge, the entire mass of a mountain over 4,000 feet in height, above the river. With the increased thickness of volcanic rocks, coarse rough volcanic breccias appear among them in greater proportion, and the impression formed in travelling westward is, that one is approaching the region of their origin. These rocks are seen, presenting much the same characters, but without again showing the lower sandstones, for about thirteen miles below the mouth of the Nicola, on the Thompson, making the width of the belt of country here covered by them about thirty-seven miles.

It has not yet been ascertained whether the sandstones and associated coals underlie the whole breadth occupied by the volcanic rocks, which may be considered as the upper part of the same formation. It is now known, however, that the coals really underlie the great volcanic formation, and may reasonably be expected to occur over a considerable portion of its area, This question is well worthy of careful investigation, especially in view of the possible passage of the railway in the vicinity of these newer coal-measures. In the locality the absence of sections sufficient for the satisfactory definition of the rocks of the lower part of the series—as on the lower Nicola Valley—they are so situated that they can be tested with comparative ease by boring in well-chosen localities. These coal-bearing tertiary strata may now, I think, be said to continue, and persist in their coal-bearing character over a region of country at least 100 miles in length. Mr. Cutlee informs me that men employed by him last summer to prospect the upper part of the Coldwater for gold, in sinking shallow pits for that purpose, found coal in about twelve different places; the furthest being about 25 miles from the junction of the Coldwater with the Nicola, and showing coal which was supposed to be of better quality than that of the original locality. In the opposite direction, Mr. Barnard has given me a small sample of coal obtained at a place about 45 miles up the North Thompson, which precisely

resembles that of the Nicola Valley in appearance. The thickness and mode of occurrence of this seam is not known. From Mr. Ferguson I have received specimens of coal from near Lillooet, and it is also reported to occur in the vicinity of Marble Canyon.

The lignites and lignite formation of Quesnel will be found described in Mr. Selwyn's preliminary report of 1871–72, and in my own for 1875–76. These beds are interesting on account of the plant and insect remains preserved in them, but the lignites are, I believe, of no economic value. They are mixed with clayey matter, and are otherwise poor in quality, and are apparently the result of the rather tumultuous deposition of drift wood and other vegetable matter, by rapidly-moving waters. Lignite of better quality, and apparently in some instances at least, still resting in the locality where the wood producing it grew, is however found in other places. Drift fragments of this fuel, of quality good enough for ordinary purposes, are found on the Nazco, Blackwater, Lower Nechacco, Parsnip and Chilacco ; and lignite is known to occur in place on Lightning Creek (Cariboo) the Upper Nechacco, and Ko-has-gan-ko Brook, besides a number of localities on and near the River Fraser, between Quesnel and Soda Creek, which have not been examined. The Ko-has-gan-ko is a stream joining the Ty-a-taesly, south of the Salmon River, and the lignite occurs on it at a distance of 8 or 10 miles from the railway location line in the valley of the last-named stream. The exposures are poor, showing only the upper part of the one bed of lignite, with a visible thickness of 4 feet, including in this measurement a few small shaly partings. The lignite itself is of good quality, and dips south-eastward at a low angle, beneath superposed flows of basalt and dolerite, which form the south-western flank of an old tertiary volcanic vent.

These lignites of the northern part of British Columbia do not compare favourably as fuels with the coals of the Nicola Valley, and would scarcely be valuable unless found in thick and accessible seams, for local use or in the absence of other fuels. Comparatively little is yet known about them, for though, as already stated, they probably underlie a great part of the basaltic plateau of this region, the soft character of the associated beds causes them to wear away, leaving hollows into which the basalts, easily crumbled by the weather, fall, concealing the lignite out-crops.

Iron.

The most important deposits of iron yet known in British Columbia, are those of Texada Island, which have been examined and briefly reported on by Mr. Richardson.* The ore is a coarsely granular magnetite, containing, according to analysis by Dr. Harrington, 68·40 per cent. of iron, with only ·003 per cent of phosphorous. It is associated and interbedded with limestones, epidotic and dioritic rocks, supposed to be of carboniferous age; and is well situated for mining, smelting, and shipment, occurring within twenty miles of the point of shipments of coals of the Comox area, and contiguous to deep harbours; while charcoal in unlimited quantities, could be prepared in the immediate vicinity. The largest exposure is on the south side of Texada Island, about three miles north-west of Gillies Bay. Here, the ore-bed is seen to be from twenty to twenty-five feet thick, and to rest on grey crystalline limestone, with which for about two feet down are interstratified bands of ore of from half an inch to an inch in thickness. From this point to the north-west, for nearly a mile, the bed is occasionally seen, and at one place there is a continuous exposure about 250 feet long and from one to ten feet thick. To the north-east it is also said to have been traced for more than three miles.† With the present high price of labour on the Pacific coast, and especially in British Columbia, the profitable manufacture of iron may appear to be a contingency of the remote future only ; especially in view of the low rate of freight at which the west coast is supplied with coal and iron from Britain, by vessels coming out nearly light, for return cargoes

* Report of Progress, Geological Survey of Canada, 1873-74, p. 99.

† Descriptive Catalogue of Economic Minerals of Can., Phil. Inter. Exhib., 1876.

of wheat from California and Oregon. In the neighbouring State of Oregon, however the manufacture of charcoal iron has been instituted for some years on a small scale, a single blast furnace being in operation with a product of 1874 of 2,500 tons, for 1875 of 1,000 tons.* Where iron ore and fuel of first rate quality can thus be obtained together, it is often possible to compete successfully, for many purposes, with the lower classed and priced iron most abundantly produced in Britain. On the Pacific Coast too, Chinese labourers can be procured in unlimited numbers, at prices so low as to compare favourably with those of any part of the world; and the Chinese are notably apt in acquiring proficiency in the more skilled mechanical arts.

Iron has been found in smaller quantities in many other localities, but little attention has been paid as yet to these deposits, under the impression that they are at present of no value. The formation containing the iron ore of Texada is believed to be the same as that constituting the greater part of Vancouver and its adjacent islands.

Silver, Copper, Mercury and other Ores.

No work but such as may be classed as prospecting or preliminary exploration, is or has been carried out on the deposits of metalliferous ores in British Columbia, Various unfortunate circumstances have prevented the testing on a large scale of the localities known to be promising, and much money has been lost from time to time in injudicious enterprises, which a comparatively small amount of knowledge of mining and metalliferous deposits in other countries would have avoided. These circumstances, coupled with the difficulty and expense incurred in exploring the more rugged and tree-clad portions of the Province, have tended of late years to discourage enterprise in this direction and to throw discredit on even the best of the known deposits. As soon as one or two properly conducted and paying mines can be seen in operation, I feel convinced that the growth of mining industry will become as rapid as it has heretofore been slow.

Silver.—The best known argentiferous locality, is that about six miles from Hope, on the River Fraser, which was discovered about 1871; it has not been visited by any member of the geological survey, and from its great elevation, is only easily accessible during the summer season. The formation in which the lodes occur, consequently remains unknown, but from what I have heard, I am inclined to believe that they may traverse an outlyer of the lower cretaceous, which caps the Cascade crystalline rocks of the region. The Minister of Mines of British Columbia describes it as follows:—"The first lead, called the Eureka mine, crops out about 5,000 feet above the river level, is well defined, four to seven feet in thickness, and has been traced 3,000 feet. A tunnel has been driven into this lead 190 feet. The ore is described as argentiferous grey copper, and has yielded under assay \$20·00 to \$1050·00 worth of silver to the ton.

"During the time the above lead was being worked, another, about 3,000 feet distant was discovered; this is of a far more valuable character, and is called the Van Bremer Mine. The ore is described as chloride of silver, and has yielded under assay from \$25·00 to \$2403·00 of silver per ton of rock. A quantity from the outcrop sold at San Francisco at \$420·00 a ton. The lead is distinctly traceable for half-a-mile."

Specimens assayed by Dr. Harrington and Dr. Hunt, gave respectively, 271·48 oz. and 347·08 oz. of silver to the ton of 2,000 pounds. Lead, copper, antimony, iron, arsenic and sulphur, are also present. As above stated, the ore from this locality has been sold at a high price in the rough state, as extracted from the mine, and carried to the river by the present rude appliances. Certain unfortunate difficulties, with regard to the ownership of the property, now only appear to prevent the successful working of this deposit.

Within the last few months, lodes, which are supposed to be either the continuations of those above described, or others running parallel to them, have been dis-

*Journ. Iron and Steel Inst No. 1, 1876 p. 238.

covered near the water level of the River Fraser, apparently in a granitic matrix. These contain silver and copper, but the former in smaller quantity than in the Eureka veins.

Cherry Creek, a tributary of the River Shushwap or Spillameecheen, between Okanagan and Arrow Lakes, is noted as a locality from which specimens of remarkably rich silver ore have been brought, and where somewhat extensive exploratory works have been carried on with the hope of finding it in paying quantity. The district has never been made the subject of geological examination, but by the descriptions which I have received, it is probable that the containing rock is of the goldbearing series. The greater part of the silver appears as red ore (pyrargerite or proustite, or both). The original vein is said to occur in the bed of Cherry Creek, between two classes of rock, a sandy slate and hard blackish slate; the latter much shattered. The best specimens of ore were taken from a lenticular mass, which thinned out in all directions, and could not be traced. The black slate of the vicinity, in many places shows small strings and lenticular masses of quartz, some of them containing silver ore, but not traceable to a main lead. I believe additional discoveries have been made during the past summer in this region, but have heard no particulars of them.

As already mentioned, native silver, or silver amalgam, has been found in the Omineca district, and argentiferous galena ores occur in many parts of the Province, but have not yet been developed.

Copper.—Masses of native copper have been found from time to time in various parts of the Province, and though they have never been observed in their matrix, they are probably derived from some of the volcanic rocks. Small copriferous veins have also been observed in volcanic rocks of tertiary and cretaceous ages, in the gold rocks, the crystalline rocks of the coast range, and those already referred to as of supposed carboniferous age in Vancouver Island. The most promising locality at present known is situated among the mountains between Howe's Sound and Jarvis' Inlet, at a height of about 3,000 feet above the sea. Very fine specimens of purple copper ore, associated with quartz, mica and molybdenite, are brought from this place, which is now in course of development. The county rock is probably granite or diorite of the cascade crystalline series.

Fine specimens of similar ore have been procured further north at Knight's Inlet, and specimens of copper pyrites have also been obtained from rocks of this series on several localities on the Homathco during the railway explorations.

Mercury.—The discovery of this metal has been several times reported in British Columbia, but generally I believe on insufficient evidence. It appears certain, however, that small quantities of cinnabar have been obtained in gold-washing on the Fraser River, near Boston Bar, and I am also informed that small globules of mercury are seen in some decomposed parts of the Hope silver ores. Last autumn I received a small, but well-authenticated specimen of rich cinnabar ore, from Mr. Tiedemann, of the railway survey, which he obtained himself in the vicinity of the located line of the railway, on the Homathco. Whether mercury occurs, however, in deposits at all comparable with those of California, which are found in rocks of similar age to some of those occurring in British Columbia, remains to be proven.

Lead—Galena has been found in many parts of the Province, and appears in connection with gold, both in the lodes and superficial gravels of the Cariboo district. Lead ores, as such, will probably not pay to work in the interior, even if found in large quantity, till cheaper means of transport are introduced. Highly argentiferous galenas would pay to smelt as silver ores, if found in moderately accessible localities.

Platinum.—This metal has been found in small quantity in several localities in association with alluvial gold.

Nickel.—Dr. Blake has found nickeliferious sand among the heavy materials separated from the fine gold of the Fraser.

Building and Ornamental Stones.

The coast range will probably furnish in all parts of its length, good grey diorites and granites. These might be quarried at the water's edge in many of the inlets. Sandstones and freestones occur abundantly in association with the coals of Nanaimo, &c. A sandstone, quarried I believe on Newcastle Island, was employed in the Treasury building at San Francisco, but has not proved very satisfactory owing to its tendency to exfoliate. By judicious selection, however, no difficulty will probably be found in obtaining building stones of this class in unlimited quantity. Over a great part of the interior, the harder rocks are so fissured and jointed, so as to be incapable of yielding sound building stones of large size. Many localities are known, however, where good stone can be obtained, and it is probable that some of the basalts and other igneous rocks of late date will answer well for building, if proper caie be taken to avoid those varieties apt to crumble under the weather. The rocks occurring in the vicinity of the various proposed railway lines are described more fully in another report.

Marble of good quality is known to occur at Texada Island, Metla Katla Bay, on the River Nimpkish, and other localities.

Serpentine is found in some abundance in association with some of the older rocks.

First List of Localities in the Province of British Columbia, known to yield Gold, Coal, Iron, Silver, Copper and other Minerals of economic value.

(This list makes no pretension to completeness, the object of its publication being rather to elicit than to impart information. It will show, however, in some degree, how numerous the discoveries have already been; and may, I hope, be largely extended in a second edition. Most of the statements made with regard to the various localities are derived from trustworthy sources. though I cannot undertake in all cases to vouch for their absolute accuracy.)

GOLD.

Cariboo District.

Williams' Creek.—Described in the foregoing pages. Its tributaries, in order, down stream, are as follows:—

McCallum's Gulch.—Joins from the east; nearly worked out; no deep ground.

Mink Gulch—Joins from the west, and prospects not considered very encouraging by owners, who are waiting for the Bed-rock flume with intention of hydraulic work.

Walker's Gulch.—Joins from the west at Richfield Court House; deep work; good prospects at different times, and some quantity of gold taken out about its mouth, but has not held out. Not yet thoroughly prospected.

Grub or Black Jack Gulch.—Joins from the west; a mere ravine of no great length, being all embraced in one claim; good pay for hydraulic method, and still worked.

Stout's Gulch.—Joins from the west, below the canyon; very rich, but now worked out for drifting; hydraulic method now employed; ground enough for many years.

Conklin Gulch.—Joins from the east, opposite Barkerville; very rich; still worked by drifting; ground very deep for so small a valley, being 90 feet in lower part and 20 in highest; drifting claim, 1½ miles up; probably rich for hydraulic working.

McArthur's Creek.—Two miles below Barkerville and one mile above Lane and Kurt'z Shaft House; joins from the south-west; paid well in drifting deep ground, but now worked out for this method; no hydraulic work in progress.

Lowhee Creek.—Runs northward, nearly parallel to Williams' Creek and empties into Jack of Clubs Lake, which also receives Jack of Clubs Creek, and is the source of the Willow River; good pay found in both shallow and deep diggings, and some good ground still being worked; gold, especially near source of creek, very course and rough, often including fragments of quartz; found difficult to obtain water for hydraulic work here.

Jack of Clubs Creek.—All deep work on this creek, gravel being 150 feet in depth near the mouth, where a few claims paid well; this creek is a favourite among those which are considered yet unimproved, the impression being that an old channel exists which has not yet been found.

Creeks entering Willow River—

Mosquito Creek and Red Gulch.—Entering Willow River from the south below the last; the former has been very rich, and was 50 feet deep at mouth, now worked out for drifting; hydraulic work paying well.

Whipsaw Creek.—Three miles below Mosquito Creek, on the same side; in former years from $10 to $12 per day per hand taken out, and more or less work carried on ever since by ground sluicing and drifting.

Several creeks below Whipsaw Creek, on the south-west side of Willow River, have afforded no pay; fair prospects have been obtained in several creeks on north-east side, but no paying ground found.

Sugar Creek.—Twelve miles below Mosquito Creek, joining from the north. Some good prospects, but never much pay.

Creeks lower down Willow River are known to hold some gold, but have not yet yielded it in paying quantity.

Grouse Creek.—Six miles east of Barkerville, heading with Antler Creek. The deep ground was very rich, and extended for about a mile near the upper part of the creek, giving out farther down. Deep ground worked out.

Antler Creek.—Heads in Bald Mountain, opposite Williams' Creek, and was one of the first creeks worked in this part of the country. Shallow ground, for two miles, paid well, and has been worked out. The deep ground has not yet been much tested, owing to the absence of clay, and consequent large quantity of water met with in sinking. All the gulches joining Antler Creek from the source down, have paid (Wolf, California, Stevens', and Begg's Gulches.) The creek has never been bottomed where these side-valleys fall in. Chinamen are at work, and getting pay on benches 100 feet above the stream, a long way down.

Pleasant Valley.—A transverse depression, four miles in length, uniting the valleys of Williams' and Antler Creeks, and joining the former about four miles below Barkerville. Has never been bottomed or much prospected, but might be embraced in a scheme for draining the valley of Williams' Creek.

Bear River, and country about Bear Lake. Gold has not been found here in paying quantity.

Swamp River.—Has attracted some attention, but no good pay has yet been found.

Cunningham Creek.—In early days, a crevice containing 600 ounces of gold, was found on this creek, about twelve miles from its mouth. Several hydraulic claims working. Since 1864, attempts to reach the deep ground have been made, but have not yet succeeded; a third attempt is now being made by the Victoria Company. It has always been supposed that the deep ground in this creek would turn out rich, and if once proved to be so, a large amount of work would immediately be undertaken.

Harvey's Creek.—The first gold in paying quantity in the Cariboo District was found here, in 1860. One claim—the Minnehaha—has been exceedingly rich. Another, at the junction with swamp river, has paid well. The Cummings Company bottomed it at one place, and drifted up in a small canyon (unsuccessfully) but found pay on entering wide ground. The upper part of the creek is deep, and has not yet been thoroughly proven.

Creeks on the North side of Cariboo Lake.—In Nigger, Pine, and Goose Creeks, small quantities of gold have been found; on the last-named, much money was spent in putting in a flume, but with small results.

Kiethly Creek.—The main creek has only moderately deep ground, (twenty to twenty-three feet,) of which, much is yet unworked; it being expensive to open, on account of the great quantity of water. About thirty white men did well here during last summer; while a number of Chinamen, at work about the mouth, also got good pay. Benches 100 feet above the stream have paid for open work, and some of them for drifting also. Hydraulic method not yet in use here.

Snow-shoe Creek.—The east branch of the above, is considered to be one of the most promising creeks of which the deep ground is yet unprospected; gold obtained from shallow workings.

Duck Creek.—Chinamen have been working here, but not much known as to results.

Black Bear Creek.—Much prospecting has been done here, but rich pay never found; not yet considered fairly tested, the ground being hard to work in.

Cedar Creek.—One pretty rich claim was worked here,—The Aurora. The creek is now worked by Chinamen.

Hazeltine's Creek.—Some encouraging "prospects" have been obtained here.

Moorhead Creek.—Some work done here, but without good result.

Kangaroo Creek.—Joins North Fork of Quesnel, about two miles above its junction with the South Fork. Paid well at one time. Chinamen now at work.

River Quesnel.—Most of the work done on bars of river, though many walkings on benches 100 to 150 feet above the water; pay well. The gold is all light. This region is altogether in the hands of Chinamen, who resort chiefly to the Forks and South Branch. About 300 Chinamen work in this district during the summer, and winter at the Forks.

Swift River.—Rather inaccessible and hard to work, being a rapid stream with many very heavy boulders. Considerable quantities of gold have been taken from it, from time to time, and Chinamen still at work, though the stream as a whole may be considered unprospected.

French Creek and Canadian Creek.—Joining Pleasant Valley from the south, have both yielded some gold, which though run through where the working was carried on, is probably not exhausted.

Canyon Creek.—A stream running into Willow River far down its course, and reached by a trail twenty miles long from Beaver Pass House. A company last autumn engaged in attempting to bottom it with good prospects.

Canyon Creek.—A second stream of the same name; joins the Fraser from the east above Quesnel. A considerable quantity of gold obtained here formerly, some of it very heavy and mixed with quartz; one nugget worth $700 found by Chinamen on its branch—*Hickson Creek*, An auriferous quartz vein is known.

Lightning Creek.—Has been described on a preceding page. Its chief tributaries are as follows:—

Amador Creek.—No good pay yet found.

Van Winkle Creek.—About 2,000 feet of the lower end this valley paid well.

Dead Mans Creek.—

Perkin's Creek.—

Chisholm Creek.—Good pay in shallow workings. Deep ground unproved, though great efforts have been made to test it.

Last Chance Creek.—Estimated that $250,000 worth of gold taken out of this creek in the distance of half a mile. Rich ground now probably worked out.

Davis Creek.—Good pay in shallow ground.

Anderson Creek.—Good pay in shallow ground.

Jawbone Creek.—No good pay found.

Quartz Veins in the Cariboo District.—Many are known, some very persistent

and of large size, but none yet proved to be rich enough to work profitably under present circumstances.

Cassiar District.

Dease Creek.—Heavy gold, good pay.

Thibert Creek.—Heavy gold, good pay.

McDame Creek.—Heavy gold, good pay. A quartz lead containing gold, silver and copper is reported on this Creek.

These three creeks are those which have produced the greater part of the Cassiar gold and it is believed that much work yet remains to be done on them, especially on the two last. Details are wanting as to other creeks in the district, some of which have yielded good prospects.

Sayyea's Creek.—(Estimated as 370 miles distant from Dease Lake. It joins the River Francis or Deloire, about 170 miles from its confluence with the Dease, and is probably situated about latitude 61° longitude 128°.) Coarse gold found here in 1875, four men taking out in 115½ days' work about seventy-seven ounces.

Omineca District.

Germansen Creek.—Good pay in part of course: some creek claims, and part of work by hydraulic method on the benches.

Mansen River.—Only two companies at work in 1875, and making less than wages.

Slate Creek.—Miners stated to be making expenses in 1875.

Elmore Gulch.—Poor pay in 1875—Two companies at work.

Lost Creek.—Little work in 1875.

Details of other localities wanting.

Kootenay District.

Details wanting.

Other Districts.

Parsnip River.—Below its junction with the Nation River, draining the Omineca country. This stream carries fine gold, which has proved highly remunerative, in some localities.

River Findlay.—Fine gold found on all the bars, but the head waters (where richer deposits may occur) have not been prospected.

Peace River, east of the Rocky Mountains.—Fine gold is found in some abundance in places. Mr. Selwyn thinks it may be derived from the Laurentian Axis to the north-east.

River Fraser.—Fine gold from its sources to the sea. Heavy gold does not extend far below Boston Bar, but is found in many places from here to Lytton, and also as I am informed by Mr. D. McIntyre, in spots from Lytton to the mouth of the Chilicotin. Much gold is still obtained by Chinamen and Indians on the Fraser, and I think it probable that, eventually, many of even the higher level flats and benches will pay for hydraulic work. The heaviest gold pretty nearly coincides in its distribution with the width of the slaty rocks of the Anderson and River Boston Bar series. The largest nugget found above Lytton was obtained ten miles below Lillooet and was worth $22.00.

McLennan Creek.—(Thirteen miles from Tête Jaune Cache, running into Cranberry Lake and thence to the Fraser.)—Gold found last summer giving wages of $4.00 to $5.00 a day, but owing to heavy boulders in stream and expense of all supplies will not pay to work.

River Nechacco.—Colours obtained near Fort Fraser and also abundantly near its junction with the Fraser.

River Chilacco.—In certain banks near its mouth eight or nine colours to the pan may be obtained. A small quantity of heavy gold found in a lateral creek by one of the men connected with the Canadian Pacific Railway survey last summer.

River Chilicotin.—Gold in some quantity said to have been found near the mouth of this stream.

Bridge River.—Gold found in heavy pieces, sometimes weighing one to two ounces, and affording excellent mining on this stream for ten miles up from its mouth. One nugget is said to have been worth $300. River prospected to its source in early days, and though gold found in several streams, not enough to justify work at that date.

River Lillooet.—Flowing into Harrison Lake. Some gold found here and also at various points on the portages toward Lillooet.

South River Thompson.—Colours, it is said, can be obtained in all the streams joining this river.

North River Thompson.—Colours found along its whole course, and at Louis Creek, 30 miles from its mouth, on the east side, gold has been found in paying quantities.

Tranquille River.—Joining Kamloops Lake, from the north. Heavy and light gold obtained here; about 60 Chinamen at work last summer, getting good pay; is said to have paid ½ ounce per diem at the mouth.

Scotch Creek, or *Adams' Creek.*—Joining Shushwap Lake from the north. White men mining heavy gold last summer.

Main River Thompson.—Heavy gold found on this river up to *Nicommen*, where it is believed the first gold in paying quantity in British Columbia was found. This region chiefly worked by the Indians of the country, who, I am assured, have obtained many thousand dollars in specially favourable years.

River Anderson.—Some heavy gold at one time found about 10 miles above mouth, but not enough to pay.

River Coquihalla.—More or less heavy gold along whole course of this stream.

River Nicola.—"Scale gold" found for about 18 miles up the Nicola from its mouth.

River Bonaparte.—A little mining done on a tributary east of Clinton, but without encouraging result.

Hat Creek.—Small quantities of gold have been found here.

Horse-fly River.—Good "prospects" here, and last summer a considerable influx of miners, but without good returns.

Great Bend of River Columbia.—Several years ago a gold excitement of some intensity occurred with regard to this region, but the results were not satisfactory.

River Skagit.—Colour found in several places in 1858, but no favourable indications.

River Similkameen.—Gold found in sharp and unwashed particles at mouth in 1853 by Captain McLellan's party. In the canyon near the 49th parallel, considerable quantity of gold got in 1858,–59,–60; the largest piece weighing $22.50. This region, soon abandoned by the Whites, was worked for years by Chinamen.

River Okanagan.—Scattered diggings found in 1859-60, but soon abandoned; perhaps as much from want of water as anything else. Miners say colours can be found in every stream running into this valley.

Mission Creek.—Joining Okanagan Lake from the east, yielded at a spot five and a half miles from its mouth, fine and coarse gold, assaying $18.50; paid at one time from two or three ounces to $2 or $3 a day. Colours occur for eight or ten miles above this.

Rock Creek.—Rising east of Osoyes Lake, and falling into the Kettle River, about a mile from its mouth paid well, in some instances yielding as much as $100 a day, but generally from one to two ounces. Some of the benches also paid, in one case yielding half an ounce a day to the hand during the season's work. The best paying ground was where the creek crossed a belt of soft slate rock; in following it up, the cover was found very soft and deep.

Boundary Creek.—Joins Kettle River from the east. Some very heavy gold found here, and a good deal of prospecting done, but too much "spotted" to be profitable.

Kettle or Nehoialpitkwa River.—Colours and small quantities of gold found in several localities on the main stream and others of its tributaries.

Seymour Creek, Burrard Inlet.—Some gold got here at one time, but work abandoned on account of water and quicksand.

Prospect Creek.—East branch Homathco River, above Tatlayoco Lake. Some fine gold found here by men connected with C.P.R.S., 1875.

Lower River Homathco.—Colours obtained in various places.

Other streams flowing from Cascade Range.—Details are wanting for most, but it is probable that colours, at least, can be found in all.

Vancouver Island.

Leech River.—This stream has proved auriferous for four or five miles of its length, where it runs along the strike of a belt of slates. Estimated that $100,000 taken out, but no work now going on. The rich ground was found in the modern river bed, and is supposed to be exhausted, or, what may remain, too much spotted to pay. Banks of drift and cement might possibly pay for by hydraulic method.

River Sooke.—(Below its junction with Leech River)—Only fine gold found here and probably derived from Leech River slates.

Goldstream Brook.—Runs on strike of Leech River slates, further east; colours, but no pay, found here.

River Jordan.—Small quantities of gold have been found here.

Other localities on Vancouver Island.—"Good colours" found by the Vancouver Island exploring expedition on a stream entering Cowichen Lake, on rivers falling into Barclay Sound, on the south side, and on streams tributary to Puntledge Lake near Comox.

Queen Charlotte Islands.—Gold-bearing quartz found at Mitchell's Harbour, lat. 52° 25′. Some work done in 1853, but lode appears to have run out.

COAL AND LIGNITE.

Vancouver Island.

Naanimo.—Bituminous coal, worked for many years Described in foregoing pages.

Comox.—Bituminous coal; now worked.

Quatsino.—Bituminous coal.

Beaver Harbour, near Fort Rupert.—Bituminous coal.

Head of Alberni Canal.—Bituminous coal.

North side Cowitchin Bay.—Small fragments of anthracite in sandstone. Larger specimens have been brought from the interior.

Queen Charlotte Islands.

Cowgitz.—Anthracite; described above.

South side Skidegate Channel.—Anthracite reported by the Indians.

Masset.—(North end of Islands)—Specimens of anthracite have been brought from here.

Mainland of British Columbia.

Vicinity of Langley, and other localities near the Lower Fraser—Bituminous coal known, but in thin seams only. Probably in lower tertiary beds.

River Chilliwack.—Five miles from the Fraser. Bituminous coal of remarkably good quality, but of which the thickness and mode of occurrence remain unknown.

Coal Harbour, Burrard Inlet.—Here and elsewhere in the flat land at the mouth of the Fraser, lignite in thin seams occurs. Probably in upper part of tertiary formation.

Junction of Nicola and Coldwater Rivers.—Bituminous coal. Tertiary. Described above.

Coldwater River.—Bituminous coal of same formation as last in several places.

North River Thompson.—(45 miles above Kamloops.) Bituminous coal. Thickness and position of seams unknown.

Vicinity of Lillooet.—Bituminous coal. Thickness or position of seams unknown.

Ten Mile Creek, or Kozoom Kanaix.—Joining River Nicola from the north. Lignite of good quality. Thickness of seam unknown.

River Similkameen.—(Above the mouth of the Pasayten.) Lignite in micaceous sandstone.

Boyds' or Cold Spring House.—Lightning Creek. Lignite bed, six to ten feet thick, fair quality.

River Fraser.—Between Soda Creek and Fort George, and at Quesnel—Lignite seams frequently seen ; that at Quesnel of poor quality.

Bear River.—(Near crossing of C.P.R. surveryed line.) Coal reported ; Mr. E. Dewdney says about eighteen inches thick and covered with water at high stage of river ; on burning left a hard stony ash. Cretacious ?

Peace River and Pine River.—Beds of bituminous coal (mesozoic) ; described by Mr. Selwyn in Report for 1875-76.

Parsnip River.—Drift fragments of lignite indicating a basin of rocks of the lignite-bearing age.

River Nechacco.—East of Fraser Lake. Drift lignite only known.

River Nichacco.—South-west of Fraser Lake. Lignite beds known in several places.

Blackwater River.—Drift lignite at upper and lower canyons, and intermediate length of river.

River Chilacco—Drift lignite only known.

River Nazco.—Drift lignite found near Cinderella Mountain.

Pun-chi-as-ko Brook.—(joining the Ty-a-taesly.) Lignite of good quality, at least four feet thick, base concealed by water.

Nasse-Skeena District.—The Skeena River is said to pass through an extensive coal formation, with coal beds three to thirty-five feet thick according to Major Downie. (This may, however, be lignite.)

IRON.

Texada Island.—Magnetite, described above.

Island near the Walker Group, Schooner passage, Queen Charlotte Sound. Exceptionally rich, 71.57 per cent. iron.

Country between River Jordan and Leech River, V.I.—Have seen a specimen of magnetite with grains of epidote from here.

Yale and Cariboo Waggon Road.—Ravine half a mile below Nicommen. Magnetite vein said to be 8 feet thick.

Knights' Inlet.—One mile up river, at head of inlet ; 1,200 up mountain, on left bank.

Near Seymour Narrows.—Six miles west from Menzies Bay, V.I. ; iron ore reported.

Entrance of River's Inlet.—West side of Fitz Hugh Sound ; iron ore reported.

Bay, S.E. of Cape Commerell, V.I.—Iron ore reported.

Mountain, E. of Mouth of Coldwater River.—Specular iron ore, only known in comparatively thin seams.

SILVER.

Silver Peak, near Hope.—Eureka and Victoria, or Van Breemer Mines ; veins probably cut cretaceous or jurassic rocks, and have been proved rich. Described above.

Other Localities, near Hope.— In at least two other localities, deposits containing silver, in greater or less quantity, are known. Country rock probably granite.

Cherry Creek.—Rich silver ore (pyrargerite or proustite,) not yet yet known to exist in veins of paying width or regularity.

Vital Creek, Omineca.—Rolled, or more or less angular fragments of silver amalgam found in considerable abundance in working placers. Specimen analysed contained 83·30 per cent. silver.

Locality about 12 *miles South of Cherry Creek.*—Large quartz vein said to have been discovered holding $10 silver per ton.

River Similkameen.– Near junction of north and south forks. Native silver found in gold placers.

River Similkameen.—Where just south of but running parallel with 49th parallel; cuts rocks containing numerous small strings of galena "readily yielding a bead of silver."

Mission Creek.—Joins Okanagan Lake from the east; native silver found occasionally with gold.

River Francis—Above its confluence with the Dease, Cassiar; argentiferous galena, a large sample of the ore was sent for assay, but I have not heard with what result.

COPPER.

Locality between Jervis Inlet and Howe's Sound.—Purple copper ore (bornite,) and copper pyrites, with mica and quartz. Large and rich masses brought out as specimens. Matrix probably granite.

Knight's Inlet.—Ore similar to the last; very rich in hand specimens, but I believe not yet found in quantity.

Entrance to Howe's Sound—(Three miles north of Atkinson Point Lighthouse.) Copper pyrites; a considerable amount of prospecting work done at one time, but now abandoned.

Sansome Narrows.—Copper pyrites. Some work done, but now abandoned. Deposit probably follows cleavage planes.

Coast two miles east of entrance of Sooke Harbour.—Shaft sunk 120 feet, at an expense of $80,000; now abandoned. Ore appears to be chiefly iron pyrites. Scales of native copper found in joints of the trap-rocks.

South-west side Dean Canal.—Specimens of vein-stone, with yellow and purple copper, were collected by Mr. Horetsky.

Head of Kitemat Inlet.—Small deposit of galena, and yellow sulphuret of copper, observed by Mr. Richardson.

River Thompson, six miles below Spence's Bridge.—Mr. Murray has given me a small angular fragment of rich purple ore, found loose, from this place.

River Thompson, nine miles below Spence's Bridge.—A rough fragment of native copper, weighing several ounces, found here.

River Fraser, about thirty miles above Fort George.—Nugget of native copper, weighing several pounds, found loose.

Bates', or 150 *mile House, Waggon Road.*—Nugget of native copper, weighing about fifteen pounds, found near here.

River Fraser, ten miles below Lillooet.—Small lumps of native copper in gold placers.

Moresby Island, Queen Charlotte Islands.—Copper found, and some money spent in prospecting; now abandoned.

Small Island off Port Frederick, Queen Charlotte Islands.—Copper ore reported by Capt. Stuart, H.B.Co.

River Homathco.—Many specimens of vein stones containing copper pyrites and some purple ore, were brought from this river. Not explored.

Traces, and small veins discolored with copper ore, found in many localities in rocks of very different ages.

OTHER MINERALS.

Platinum.—Found in scales in association with gold on the Similkameen River.

Platinum.—On the Fraser River, ten miles below Lillooet, very fine scales of platinum found with gold.

Antimony and Arsenic—(arsenical pyrites?) Specimens brought by Indians to Captain Stuart probably from Kummeshaw, Queen Charlotte Islands.

Iron Pyrites.—Specimen of massive pyrites, said to exist in large quantity, brought from Copper Island, Barclay Sound.

Plumbago.—Specimen of Plumbago obtained by the Vancouver Island exploring expedition in the country north-east of Port San Juan.

Nickel.—Nickeliferous sand obtained in gold-washing on the River Fraser, consists of magnetite, and pyritous grains attracted by the magnet which consist of oxides of iron and nickel. (J. Blake, M.D., Proc. Cal. Acad. Sci., V. p. 200).

Molybodenite.—Specimen brought from the upper part of the Cowitchin River by Mr. W. Robertson.

Molybdenite.—In association with copper ore at locality between Jarvis Inlet and Howe's Sound.

Cinnabar.—Specimen obtained by Mr. Tiedeman in the Homathco River.

Cinnabar.—Grains obtained in gold-washing near Boston Bar.

Lead.—Galena in many places, some of which are mentioned above in other connections.

APPENDIX S.

NOTE ON AGRICULTURE AND STOCK RAISING, AND EXTENT OF CULTIVABLE LAND IN BRITISH COLUMBIA; BY GEORGE M. DAWSON, ASSOC., R.S.M., F.G.S. OF THE GEOLOGICAL SURVEY OF CANADA.

The limiting climatic conditions of agriculture in British Columbia may be classified under the following heads:—Excessive rainfall; want of sufficient moisture; and too great elevation, leading to summer frosts and a shortened growing season.

On the west coast of Vancouver Island the amount of rainfall and of cloudy weather is so great, that the profitable cultivation of cereals is probably not possible, even were the surface of the country otherwise adapted for agriculture. This has been found to be the case at Cape Flattery, on the southern side of Juan de Fuca's Strait, and also according to Mr. Richardson, at Bella Bella and Fort Simpson; and from their analogous position, no doubt, obtains on the west coast of the Queen Charlotte Islands and those parts of the mainland upon which the southerly and westerly breezes of the Pacific strike without previously passing over mountainous islands. Thus at Sitka, in the southern part of Alaska, the rain fall averages 82.66 inches,* while overcast or wet weather prevails on two days out of three, the year round. The rainfall on the open coast near the mouth of the Columbia River, is not much less, and on the eastern slopes of the Cascade or Coast Range about the Salmon River, there are evidences of a snow and rain-fall considerably greater than on the portion of the same range further south, sheltered by Vancouver Island. The vicinity of the ocean and great rainfall of the coast are accompanied by a mild and uniform climate. The following table, kindly supplied by Professor Kingston, shows the character of the coast climate, as compared with that of the interior; Esquimalt representing the former and Spence's Bridge the latter:—

——	Mean Temperature.	Mean Summer Temperature.	Mean Winter Temperature.	Clouded Sky.	Total Annual Precipitation.	Mean Highest Temperature.	Mean Lowest Temperature.	Absolutely Highest.	Absolutely Lowest.	Range.
	°	°	°	p. cent.	inches	°	°	°	°	°
Esquimalt..........................	47·97	57·82	34·45	54	29.66	81·70	13·20	85·0 Aug. '74	8·0 Jan. '75	68·50
Spence's Bridge.............	47·08	68.23	23·93	47	11·30	97·60	—14·80	100·0 June '76	—29·0 Jan. '75	112·40

The winter temperature of Esquimalt is taken from that of the months of January, February and March; that of Spence's Bridge, from January, February and December. The summer temperature at both stations from June, July and August.

* Average of sixteen years. Alaska coast Pilot, 1869.

The region of the coast suited for agriculture by its climate, is that sheltered from excessive precipitation ; and in this position lie the low and fertile lands of the east coast of Vancouver Island (including Esquimalt station in the above table) the delta and part of the valley of the Fraser, and the flat land probably existing on the north-eastern portion of the Queen Charlotte Islands. Of the low country reported to exist in the Nasse-Skeena region, very little is known.

In reference to the eastern, Vancouver, and Fraser Estuary country, constituting the chief area of arable land on the coast, so much has already been written,* that it will be unnecessary to refer to it in other than general terms. On Vancouver Island the cultivable land is chiefly that which is covered with drift deposits of clay and sand, and lies at no very great elevation above the sea. A great part of it coincides in extent with the area occupied by the softer rocks of the cretaceous coal formation. The surface soil is generally of a dark brown colour, and in some places graduates downward into the drift, while in others it is separated by a rather sharp line from it. It follows the undulations of the surface, and Mr. Richardson describes it as generally gravelly and light at the higher levels, and finer grained at the lower. It may not improbably be of marine origin and formed during the emergence of the land. The area of arable land on Vancouver Island is however not large; the only estimate which I have seen is that quoted by Mr. Sproat.† This however manifestly refers to the surveyed portions only of the districts named. The distribution of the land is as follows:—

Near Victoria, say	100,000	acres.
Saanich, Peninsula	64,000	"
Sooke—out of five square miles	3,750	"

Cowitchen,—portions surveyed (including Shawnigan, Quamichan, Somenos Comiaken), 100,000 acres; of which half considered superior.

Salt Spring Island—area, 90 square miles, of which 5,750 acres good.

Nanaimo—(Mountain, Cranberry and Cedar districts,) 45,000 acres, a fair proportion superior.

Comox—50,000 acres. Very good.

The above is estimated to give an area sufficient for the support of 30,000 country people.

With regard to the interior of Vancouver Island Mr. Sproat says,‡ "I do not think there is very much farming land in the interior of the island anywhere in mass, though detached pieces on lakes in valleys would no doubt make a considerable area, if all were put together." The explorations of Mr. R. Brown and others, to whom our slight knowledge of the interior is due, seem to confirm this statement.

The fertility of the soil of Vancouver Island is very great, and goes far toward compensating for its comparatively small extent. All ordinary cereals and crops flourish. I do not think Mr. Anderson exaggerates in stating the ordinary yield of wheat at from 30 to 40 bushels per acre, while oats are said to produce frequently as high as 60 bushels. Hops, for which the climate and soil seem specially suited, yield from 1,200 lbs. to 2,000 lbs. per acre in favourable seasons. Mr. Richardson obtained the following statement of the average yield of land in Comox district, when cleared and thoroughly under cultivation:—

Wheat from	30 to 45	bushels per acre.	
Barley "	40 to 45	do	
Oats "	50 to 60	do	
Pease "	40 to 45	do	
Potatoes "	150 to 200	do	
Turnips "	20 to 25	tons	do

* *See* especially B.C. Information for emigrants, issued by the Agent General; A. C. Anderson's Brief Description of B. C., 1872, and Mr. Richardson's various reports in the Memoirs of the Geological Survey 1871-'72 to 1874-'75.

† B. C. information for Emigrants p. 39.

‡ *Op. cit.* p. 40.

Crops like these appear so remarkable to those engaged in farming in the East, that the accuracy of the returns has often been questioned, but they have been repeatedly confirmed, not only in British Columbia, but in parts of Washington Territory and in Oregon. These results are, however, only obtained from land in first-rate order; and the soil may of course be impoverished to any extent by bad farming, and has already in many instances been much run down in this way.

All fruits suited to temperate climates thrive admirably on the east coast of Vancouver Island, and some of them attain a size and perfection seldom found elsewhere, and show a strong tendency to develop new varieties. The number of cattle raised on Vancouver Island must, under present conditions, be quite limited, as the flat and open country can be turned to more profitable use otherwise. Small herds, however, do well the year round, with little attention, in the more thinly wooded portions of the hilly country; where they find many edible plants, and browse also on the nutritious lichens which hang from the branches.

A great part of the low land, which will eventually be brought under cultivation, is now covered with gigantic forests, and at the present rates of labour it is scarcely attempted to render it available, notwithstanding the high price of farm produce.

The flat land about the mouth of the Fraser, probably rests over nearly its whole extent on soft tertiary formations, but along its low, seaward margin is composed, to all appearance, of very modern delta deposit. With it may be included the low country about Sumass Lake, the Chilliwhack and Pitt Rivers, forming together a somewhat extensive region. The greatest drawback to this country is its liability to flood, the coastward portion of it by the backing-up of river water by the tide, the inland basins by floods arising from the melting snows in early summer. There is, however, a very considerable area fit for cultivation in its present state, and much high land which will in time be made available by the removal of the great forests by which it is now covered. It is believed, also, that by a system of dyking, which if carried out by Government on a general plan need not be very costly, a great stretch of the extremely fertile delta land, can be permanently reclaimed. Something has already been done in this way by individual effort, but at a comparatively great cost. Of the total amount of agricultural land I have no means of forming an exact estimate, but I believe the area ultimately available for this purpose will not fall short of 500 square miles, while it may considerably exceed this figure. Mr. Dewdny informs me that about 400,000 acres (625 square miles) has already been surveyed into townships; of which he estimates about 230,000 as prairie or lightly wooded, to which 10,000 to 15,000 acres representing good land near the Fraser between the Chilliwhack and Hope, must be added.

The climate, though with rainfall somewhat in excess of that of the southern part of Vancouver Island, closely resembles it in most respects, rendering it unnecessary to repeat the statements made with regard to products. Stock-raising can, at present, however, be more profitably followed here than on the island, as much of the low country now liable to flood yields very fine hay and grazing. This region and those of the east coast of the Island have the advantage of cheap water communication by which to send their produce to market. Owing, however, to the limited extent to which farming is now carried on, and the want of sufficient attention to the business, the country is not yet nearly self-supporting, being obliged to import large quantities of flour, cattle, and farm produce of all kinds.

The natural flora of the country, closely depending on its climate, may, with certain precautions, be safely used as indicative of the climate in those regions for which regular meteorological observations do not exist. With the damp air and equable temperature of the coast, we find a correspondent luxuriance of vegetation, and especially of forest growth. In a few spots only—and these depending on the dryness of several of the summer months owing to local circumstances—does a scanty representation of the drought-loving flora of the Californian coast occur.

The flora of British Columbia, as a whole, may be broadly divided under four great classes indicating as many varieties of climate; these may be named as follows:—The *West Coast*, the *Western Interior*, the *Canadian* and the *Arctic*. The

first, characterized as above described, is that of the region west of the Coast Range, and is well marked by the peculiarity of its plants. The second is that of the southern part of the interior table-land of the Province, and presents a general similarity with that of the interior basin of Utah and Nevada to the south, and to that of the drier portions of the great plains east of the Rocky Mountains. It may be said to extend northward to about the 51st parallel, while isolated patches of a somewhat similar flora occur on warm hill-sides and the northern banks of rivers, to beyond the Blackwater. In the northern part of the interior of the Province, just such an assemblage of plants is found as may be seen in many parts of eastern Canada, though mingled with unfamiliar stragglers. This flora appears to run completely across the continent north of the great plains, and characterizes a region with moderately abundant rainfall, summers not excessively warm, and cold winters. The Arctic or Alpine flora, is that of the higher summits of the Coast, Selkirk, and Rocky Mountain Ranges, where snow lies late in the summer. Here plants lurk which deploy on the low grounds only on the shores of Hudson Bay, the Icy Sea, and Behring's Strait.

East of the Coast Range of British Columbia, lies the great interior plateau or table-land, about one hundred miles in average width, closed northward by an irregular mountanious country about latitude 55° 30′, and to the south by a second irregular transverse mountainous region, near the 49th parallel. The climate of the interior is in marked contrast to that of the coast, being essentially one of extremes. Though the mean annual temperature differs little in the two regions, a greater difference is observed between the mean summer and winter temperatures, and a still greater contrast when the extremes of heat and cold—as exemplified by Spence's Bridge and Esquimalt—are compared. The rainfall in the southern part of the interior is extremely small—at Spence's Bridge 11.30 inches—giving rise to the open or lightly timbered bunch-grass country, so favourable for stock-raising. Northward, it increases in amount, and at the same time the forest covering becomes more dense, till in the vicinity of the group of great lakes in the northern part of the plateau, judging by the flora and appearance of the vegetation, it is little less than in eastern Canada.

The greater part of the interior is, however, unsuited to agriculture, by reason of its too great elevation; while in the southern portion, the third limiting cause affects those districts otherwise arable—the rainfall being deficient for the growth of crops.

In the southern interior, the cultivable land is limited to those tracts of the bottoms and slopes of the numerous wide trough-like valleys by which it is traversed, which can be successfully irrigated. Northward, at Quesnel (latitude 53°) and beyond, irrigation is not necessary; and in the lower part of the Nechacco basin, the greatest unbroken spread of low fertile country is met with.

The soils of the interior may be broadly arranged in two classes. 1. Soils chiefly composed of unmodified drift, representing the boulder clay of some other regions. 2. Soils composed of modified or redistributed drift, modern alluvium, &c. The first class, though spoken of technically as "boulder-clay," has not here the stiff clayey character very generally found in that formation elsewhere, but is composed as a rule of a yellowish-grey mixture of clay and sand, rather hard in consistency, through which stones of all sizes are irregularly scattered. When exposed at the surface to the weather, it becomes softened and broken down, and superficially mingled with vegetable matter. Though its materials are in great part derived from the immediately underlying rocks, it contains much foreign matter, by which any deficiencies in its composition arising from the character of the local formation, are corrected. Judging from the forest and sward which this soil bears when otherwise favourably situated, it must be fertile; but it lies in the main, if not entirely, above the limits of successful agriculture.

The regions low enough for farming are based on the soils of the second class, which are much more varied in character. They are chiefly the products of the disintegration and re-arrangement of the boulder clay, though mingled also with

detritus derived from the waste of the local rocks since the glacial period, or carried down by rivers when flowing at a higher level. They form the benches or terraces which are displaved on so large a scale in British Columbia, the irregular slopes of some of the valleys of the south, and the modern river flats. Their texture varies from that of fine, almost clayey, material, to coarse, sandy, and gravelly beds; but in general they preserve a mean character in regard to size of particles, and are extremely fertile. To this class the soil of the flat country in the Lower Nechacco Basin belongs. This area has, no doubt, at a former period been the bed of a great lake, with the fine sediments of which it is now covered to a varying depth, but in some places probably exceeding 200 feet. The beds are usually pale in colour, calcareous, and found when examined microscopically to be composed of very fine angular silicious matter mixed with calcareous and argillacious particles, resembling in appearance, and probably in mode of origin, the *loess* of the Rhine, and the subsoil of the Red River Valley in Manitoba. These deposits, which form an extremely fertile soil, I have called the *white silts.*

The extraordinary crops which, when favourably situated, the soils of the interior everywhere produce, bear witness to their uniform fertility, which is largely owing to the quality of modern igneous rocks which have been incorporated with them. The following facts as to yield of grain, etc., of irrigated farms in the interior, appear in Mr. Selwyn's report for 1871–72.

At Carson's Pavillion Mountain Farm the average crops obtained are:—

Wheat per acre	1,400 to 1,500	lbs.
Barley " "	1,300 to 1,500	"
Oats " "	1,600 to 1,800	"
Potatoes " "	30,000 to 40,000	"

The oat crop sometimes reaches 2,700 lbs per acre. Timothy grass from $1\frac{1}{2}$ to 3 tons per acre.

At the Australian Ranche, 20 miles below Quesnel, the yield of crops was as follows:—

Wheat per acre	2,500 lbs.
Barley " "	2,500 "
Oats " "	2,500 "
Turnips " "	25 tons of 2,000 lbs
Potatoes " "	25 " " " "
Timothy grass " "	$1\frac{3}{4}$ " " " "

The three thousand foot contour line may be taken as roughly indicating the extreme upward limit of agriculture in the interior, and on examining the relief of the country it will be noticed, that in its southern portion nearly all the main river valleys, and many of those of the smaller streams lie below this level; while the general surface of the country stands above it, and would form, were water at this elevation introduced, groups of irregular islands separated by narrow lanes of water, North-westward, the country below the contour line of 3,000 feet opens out, till wide shallow valleys are formed, including the whole basin of the *white silts.*

In using the three thousand foot line as broadly limiting the possible upward extension of agriculture, it is not intended to affirm that wheat can be ripened to this elevation, for in all probability the profitable growth of oats and barley will not exceed it, and in some regions fall considerably below it. The height at which immunity from summer frosts is obtained. varies considerably in different localities, and often seems to depend on local circumstances difficult to define. Valleys shut in, and forming a small area of low ground among high mountains, are less favourably situated than land at the same height where forming a broader expanse. It appears to be from this reason that there is little difference between the height to which crops may be raised in the southern and northern parts of the interior, through nearly five degrees of latitude.

Between Cache Creek and Clinton, on the waggon road, are several farms at a great elevation, the highest being, by barometer, 2,800 feet. I am assured that wheat will ripen here, but is not generally grown, barley being a surer crop and selling better. This is probably about the limit for the growth of grain in this region, though Mr. Sproat states that one may see "fine grass and good grain growing (of course with some risk) on Pavillion Mountain, 4,000 feet above the sea level; excellent grain growing and harvested; also cabbages, carrots, turnips and potatoes elsewhere at 2,700 feet; vegetables of all kinds and grain luxuriantly at 2,000 feet."* On Riske's Creek, north of the mouth of the Chilicotin, at an approximate elevation of 2,400 feet, fine wheat, and grain of all sorts, are grown without injury from frost.

At Quesnel, grain crops are sown from April 20th to the 1st of May; potatoes planted somewhat later. The grain is harvested about the middle of August. Wheat, barley and oats are cultivated, and all succeed well, though the two last are the most profitable, as they can be sold in Cariboo without milling. Night frosts happen here occasionally in June, but are not usually severe enough to do damage to potatoes, though sometimes checking them a little. On one occasion, potatoes are known to have been so completely frozen down as to prove a failure. The Hudson Bay Company formerly cultivated a farm at Alexandria between Quesnel and Soda Creek, on which, on certain portions of the land, 40 bushels of wheat to the acre, by careful measurement, were grown.†

At Fort George (near latitude 54°) the season of growth for crops, does not differ materially from that of Quesnel, and grain of all kinds may be ripened. The elevation here is 1,880 feet. Winter is said to set in about the 1st of November, though steady cold weather may not continue from that date. In December and January, there is often a few days' thaw. In March, the snow thaws in the sun every day, the thermometer falling below the freezing point at night. In April, the snow disappears, and by about the 20th of the month the ground is fit to work. At Fraser Lake (2,225 feet) potatoes and other root crops are grown near the Hudson Bay establishment, and barley and wheat were formerly cultivated, though it is now found cheaper to import flour. The Indians have little garden patches with potatoes, turnips, etc. At Stuart Lake (2,200 feet) near Fort St. James, garden vegetables and root crops succeed admirably, and potatoes and barley are grown in considerable quantity. I do not know whether wheat has been tried, but with proper care, it would, no doubt, succeed in most seasons, if not invariably.

In all these places the complaint of summer frosts is made. These usually happen in June, and may occur on one night only, or on two or three nights, and are often severe enough to touch potatoe-tops, and occasionally to harm the plants considerably. It is said, however, that these frosts have only occurred of late years, and that formerly they were unknown. It hardly seems probable that any great change in climate is taking place, and it is quite possible that the necessity for farming having to a great extent been done away with, sufficient care has not been given to cultivation, or to the renewal of the seed, which is apt gradually to deteriorate and lose the vigour necessary for successful growth in northern latitudes. Nor are the most judicious localities always chosen for the more delicate crops, the lowest ground, or that nearest the fort being often selected, while higher slopes may be less exposed to frosts. It is not probable that wheat will grow over the whole area of the white silt deposits of this region; but I think barley would flourish over nearly the entire area, while wheat may be successfuly raised in chosen spots. The quality of the grain seen at Fort Fraser was excellent.

It is very difficult, with the information now accessible, to form even an approximate estimate of the quantity of arable land in the interior of British Columbia. I have only seen a few parts of the southern portion of the interior plateau, but judging from these, and facts obtained in other ways, I am inclined to believe that the cultivable land east of the Fraser is probably in area less than 1,000 square miles. It is

* Information for Immigrants, page 62.

† A. C. Anderson, *op. cit.*, p. 48.

to be remarked, however, that this area does not at all adequately represent the capacity of the country to support a population, as a comparatively small patch of arable land serves the stock-farmer, whose cattle roam over the surrounding high country. West of the Fraser, as far north as the Blackwater, the cultivable areas are very small. The so-called Chilicotin Plains, lie too high for farming, and the available area in the valley of the Chilicotin was roughly estimated by me in my report for 1875, at 7,000 acres only. An area of 300 square miles might be perhaps taken as an estimate of the farming land of this region. North of the Blackwater is the Lower Nechacco basin, already more than once referred to. The area of this is probably about 1,000 square miles. Bordering on François Lake are considerable stretches of country not raised so much as 300 feet above it, and therefore considerably below the 3,000 foot contour. The soil is very fertile, and the vegetation much resembles that of the *white silt* basin. Supposing this country to be suited to the growth of barley, oats and the hardier root crops, which appears highly probable, though no trials have of course been made, an area roughly computed at about 200 square miles will be added.

It is much to be desired that regular metereological observations could be made at some place such as Fort Fraser, or Fort St. James, which would fairly represent the climate of the northern low country, and remove the feeling of uncertainty with regard to its capabilities, which to some extent must obtain with our present knowledge. My impression is that a great part of it is suited to the culture of the hardy cereals and root crops, at least; and Professor Macoun, in his report in connection with Mr. Selwyn's expedition of 1875, speaks highly of it.

Agriculture proper, however, must always take a secondary place in the interior, and stock raising constitute the chief wealth of the country. Cattle and horses winter out from the 49th parallel to Fort Fraser in lat. 54° a stretch of 450 miles. The capablities of British Columbia as a stock-raising country are so well known that little need be said on this point. The " bunch-grass " country, pre-eminently, is that east of the Fraser in the southern part of the Province, where the rain and snowfall is light, and the hills bare and grassed almost to their summits. But even northward, in the thickly wooded country, there are many fine valleys with grassy northern slopes and extensive hay swamps, which in the aggregate must form a very great area capable of supporting stock. Though, as above stated, cattle can winter-out without attention, and in many cases appear fat and in good condition in the spring, a severe season occasionally happens, in which if no provision is made they may suffer much privation, and a considerable mortality may occur. It is thus always better to have a small quantity of hay in readiness, and with this precaution cattle-raising may be made a certain business. Sheep succeed admirably in the Kamloops' country, but at present even the wool scarcely remunerates the farmer, when he has paid the expense of carriage to the sea-board.

No precise statistics appear to exist in reference to the numbers of cattle, sheep, horses, etc., now in the province, but Mr. Sproat, in the publication above referred to, dated 1875, gives the following as an approximation :—

Horned Cattle	35,000
Horses	6,000 to 7,000
Sheep	12,000 to 15,000
Pigs	10,000

This appears to be rather a low estimate. Stock of all sorts is rapidly on the increase, and the chief want of the farmer is an outlet to a market.

In the foregoing notes no reference has been made to the portion of the Peace River County included in British Columbia, of which I know nothing personally, but which is fully described in Mr. Selwyn's report for 1875. They also refer to the *present* condition of British Columbia. I feel convinced that by the agency of man great changes will be produced, as has happened in other countries. The reckless destruction of the forest areas of the southern portion of the interior, by fire or otherwise would, no doubt, cause a gradual dessication of the soil and climate. To the

north, however, great regions of plateaux are covered with scrub pine and other trees small in size and unfit for most economic purposes. The destruction of this useless forest by fire, is followed by the growth of grass, with groves of aspen poplars, and the drying up of the peaty swamps of the little hollows. Such areas will eventually add largely to the available grazing grounds, and even where situated at a very considerable altitude will serve for summer pasture. Irregular plateau and mountain country, at yet greater elevations, is still of some value. The vigorous growth of timber ceases at between 4,000 and 5,000 feet over most of the Province, above this limit, park-like open country is found. Considerable regions of this nature occur even among the Bald Mountains of Cariboo, on the snowy volcanic ranges, south of the sources of the Blackwater and Salmon Rivers, and elsewhere, and during the summer months yield alpine pasturage of the most nutritious description.

APPENDIX T.

DESCRIPTION OF THE ENGINEERING FEATURES OF CERTAIN LINES IN BRITISH COLUMBIA TO WHICH ATTENTION HAS BEEN SPECIALLY DIRECTED.

OTTAWA, 18th April, 1877.

SIR,—I have the honour to submit the following description of the engineering features of certain lines selected from the three groups diverging from the Yellow Head Pass in the Rocky Mountains to different points on the coast of British Columbia.

For convenience of reference, I have divided the several lines into *Districts* and *Sections;* the former determined by the great natural divisions of the country, the latter being taken in convenient lengths possessing distinct engineering features.

1st District, ... In the Rocky Mountains.
2nd " .... On the Central Plateau.
3rd " .... In the Cascade Mountains.

LINE No. 2 IN SOUTHERN GROUP, EXTENDING FROM YELLOW HEAD PASS TO BURRARD INLET.

This line commences on the divide or watershed in the above pass, from which the streams flow north-eastwards into the Arctic Ocean, and south-westwards into the Pacific. The height of this point is found by repeated check surveys to be 3,733 feet above the level of the sea, but as the railway will there be in a slight cutting the height of the rail level may be taken at 3,730 feet.

IN THE ROCKY MOUNTAINS.

Section 1.—*From the summit of the pass to the foot of Moose Lake,* 29 *miles.*

From the summit of the pass, the line follows down a deep narrow valley on a westward course by the side of a small stream supplied from springs, melted snow and rain on the mountain slopes. At two and one-half miles it reaches Yellowhead Lake which is three and a half miles in length, with a maximum breath of about a half a mile. This collects the waters of other small streams from the mountains, and forms one of the sources of the main branch of the river Fraser. The outflow of this lake is a shallow stream about 100 feet in breadth.

A little below this, a stream of about an equal volume comes in from the south.

The line follows the north shore of the lake and the stream flowing out of it, and at 13¾ miles it crosses Grant's Brook, 50 feet wide, coming in from the north. At 16½ miles it crosses Moose River, about 150 feet wide, which also comes in from the north. At 18¾ miles it reaches the head of Moose Lake, which is 3,400 feet above sea level. But the formation level of the railway at this point is 3,434 feet, making a total fall of 295 feet in 18¾ miles, an average of nearly 16 feet per mile; the gradients, however, are variable, the maximum being at the rate of 1 per 100, of which there are two lengths, making together three miles, rising eastwards.

Moose Lake is eight miles long and about half a mile in average breadth. The line follows its north shore to the outlet, which is a stream 200 feet wide in slack water, but in the current it is about 150 feet wide.

The altitude at this point is 3,414 feet above sea level, showing a fall of 20 feet in the last 10 miles, with undulating gradients, the highest of which is 0·75 per 100, or 39·6 feet per mile for a little over half a mile in length.

The works on this section of 29 miles will be moderate, the cuttings not deep, and principally in sand and gravel mixed with boulders and some loose rocks which have rolled down the side of the valley from the cliffs above.

Section 2—From the foot of Moose Lake to Cranberry Lake, 29th to 58th mile.

From Moose Lake the line follows the right, or north bank of the Fraser about three miles on gravel benches nearly level, and the works will be light. It then crosses the river and follows the south slope of the Fraser Valley 17½ miles, with an average descending gradient of 35 feet per mile; the only variation from a uniform gradient being one of 43½ feet per mile for a mile and a half, and another of 21 feet per mile for about the same distance.

Of this 17½ miles, 6 miles are on granite, the same distance on slate rock, and the balance on shale, with solid rock cropping out at intervals. The works therefore will be rather heavy though the cuttings are not deep. There will be three tunnels, the united lengths of which will be about 2,600 feet. From this point, which is opposite Tête Jaune Cache, the line takes a southward course into Cranberry Valley, and descends obliquely its southern slope for about six miles, till it re-joins the line surveyed in 1872, from three to four miles north of Cranberry Lake.

On this six miles the works will be rather light, and there will be no rock cutting.

The plans and profiles of that portion of the line from Cranberry Lake to Kamloops were unfortunately burnt in the fire of 1874, and as no re-survey has been made I can only repeat the description given of that portion of the line in the progress report of 1874.

Section 3—Cranberry Lake to the Valley of the North Thompson, 58 to 82 miles.

From Cranberry Lake to the crossing of Canoe River, 3½ miles is practically level, as the surface of the river is only 20 feet below that of the lake; thence to Lake Albreda, 10 miles, there is a rise of 264 feet. This is on the watershed between the tributaries of the Thompson and Columbia, and, by our surveys, is 2,866 feet above sea level. From this point the line follows the Albreda to its confluence with the north branch of the Thompson, a distance of eleven miles, in which the descent is 430 feet.

For about half the distance the gradient on the preliminary trial survey exceeds one per 100, but by a slight deviation it can be reduced to that, or probably a lower, rate of inclination. On this section the works will be light or moderate.

Section 4.—North Thompson Valley, from the mouth of the Albreda to the mouth of the Clearwater, 82 to 182 miles.

At the mouth of the River Albreda, the line crosses the north branch of the Thompson and follows down its right or west bank, near to its confluence with the Clearwater, where it re-crosses to the left bank at an angle of about 45°, requiring 400 feet of bridging.

In this distance of 100 miles the river falls 1,080 feet. This fall is not uniform, but in no case will the gradient exceed one per 100. Rather short curves will have to be used in several places.

The general character of the works on this portion will not be heavy, as the line runs on low flats for about one-fifth of the distance, and the rest on gravel benches, or on the face of easy slopes, with the exception of about eight miles through the canyon, where the works will be heavy.

Two-thirds of the distance through the canyon is on slate rocks with short cuttings of 20 to 30 feet maximum depth; the balance will be very heavy rock cutting, with a considerable length of tunnelling, but by bridging the river twice the tunnelling can probably be reduced to one of 300 feet, and another of 800 feet in depth.

About four miles above the mouth of the Clearwater, one of the lines to Bute Inlet branches off. The altitude at that point is 1,397 feet above sea level.

ON THE CENTRAL PLATEAU.

Section 1.—*Clearwater to Kamloops*, 182 *to* 255 *miles.*

At Clearwater, the line is free of all the ranges connected with the Rocky Mountains, but the Thompson valley to Kamloops is narrow and sunk deep in the plateau.

From this, the line follows the left bank of the north branch of the Thompson to its junction with the south branch, where it crosses the latter, requiring 200 feet of bridging; altitude 1,170 feet above sea level. It then follows the left bank of the united stream to Kamloops, about a mile lower down.

In this distance of 73 miles, the river falls 191 feet, or under 3 feet per mile. The gradients of the line are easy and undulating, only varied in passing from one bench to another of different height, or in rising over a rocky spur to reduce the quantity of excavation.

The heaviest work on this section commences about 11 miles below the mouth of the Clearwater, and continues for about four miles, in which there are a number of spurs of compact slate rock to be cut through, in lengths of 300 to 800 feet, and from 15 to 30 feet of maximum depth; amongst those is the Assiniboine Bluff, 700 feet in length, of which about 200 feet will have to be tunnelled.

Below this, at various points, the high benches of clay, gravel or shale, come very close to the river, and in these there will be some heavy cuttings in short lengths, the lower portion of which will be in slate rock; there are eleven miles in which this class of work occurs.

For the rest of the distance, the line runs on benches and low flats, and the works will be light; altogether this section of the line is very satisfactory, and the works on the average will not be heavy, but medium, and might almost be classed as comparatively light.

Section 2.—*Kamloops to Savonna's Ferry*, 255 *to* 280 *miles.*

At Kamloops (255th mile), the north and south branches of the River Thompson unite; and thence the line of exploratory survey made in 1872 follows the left bank of the joint stream about seven miles down to Lake Kamloops with easy gradients, and the works will be moderate.

Thence its course is along the south shore of the lake, on which, at 263½ miles, it encounters a range of volcanic rocks, extending about five miles; no levels are given over this portion, but for about half its length, the perpendicular basaltic cliffs project into deep water, with extremely irregular outline, so that very heavy rock excavations and probably over a mile of tunnelling will be required.

From this to the outlet of the lake at Savonna's Ferry (280th mile), the line follows the shore, with easy undulating gradients, along the slopes of the hills.

On half this length of twelve miles, the works will be moderate, on the other half they will be rather heavy, as many of the cuttings will be in rock, and on the the sides of clay bluffs, and some protection works will be required against the waves of the lake, and against probable land slips.

Section 3.—*Savonna's Ferry to Lytton*, 280 *to* 350 *miles.*

The altitude of Lake Kamloops is 1,130 feet, approximately, by this survey, which, however, is not very reliable. From its outlet, at 280 miles, the line follows the left bank of the Thompson to its junction with the Fraser at Lytton, at 350 miles.

The whole of this is over difficult ground; the valley being a succession of benches, varying from 20 to several hundred feet in height, furrowed by deep, lateral ravines. Frequently, the higher benches come close to the river and terminate in broken slopes of clay, gravel, or loose rock. These are varied at intervals by rocky spurs from the mountains shooting right into the river and diverting its course, or occurring simultaneously on both sides and thus forming a rocky canyon.

The fall in this distance of 70 miles is only 510 feet; but to avoid excessively heavy works, the line will have to be carried, in some places, close to the river; at others, on the high benches or well up the slopes of the valley, so that the gradients will be undulating, and the maximum of 1 per 100 will have to be frequently employed, alternately rising eastwards or westward.

Not even a rough approximate estimate can be made of the extent of the works, from the profile of 1872; for with the free use of this maximum gradient, the proportion of excessively heavy works would still be so great as almost to condemn this line as impracticable. It is, however, very probable that a careful location survey would give more satisfactory results.

IN THE CASCADE MOUNTAINS.

Section 1—*Lytton to the crossing of the Fraser*, 350 *to* 358 *miles.*

During the season of 1876, a re-survey was made on this line between Lytton and Yale.

The altitude of the line at Lytton (350 miles) is 690 feet above sea level, and that of the river about 200 feet lower. From this point it follows the left bank of the Fraser to a point near Kanaka Bar, at 358 miles, where it crosses the river and then follows the right bank down to Yale at 403 miles.

The fall in this length of 53 miles is only 510 feet, but to avoid excessively heavy works, the course of the line is continually varying. Now, it is on the river bank a few feet above the flood level; then, it is high up on the slope of the valley, so that the gradients are rising now east then west, and the aggregate length that the maximum gradient of one per 100 has been used between Lytton and Yale (53 miles) is 14¼ miles rising eastward and 6½ miles rising westward.

The excavations on this section will be rather heavy, but chiefly in gravel and boulders, with a few in rock. There are five ravines that will have to be bridged or crossed with an embankment. The two largest are 90 and 95 feet deep, respectively, 350 and 400 feet wide at formation level, but their slopes nearly meet at the bottom.

Section 2----*On the Right Bank of the Fraser to Boston Bar*, 358 *to* 380 *miles.*

The crossing of the Fraser at the 358th mile is 1,500 feet wide at formation level. High flood level is 87 feet below this, and low water 135 feet below. There are rocks projecting into the river on both sides, standing above high-water level, on which piers could be built, so that the water-way could be bridged with two spans, one of 350 feet and the other of 250 feet in length, and the approaches with four spans of 100 feet each; the balance of 500 feet will be embankment.

On the next half mile there will be heavy rock excavation and a tunnel 700 feet in length.

From 359th to 368th mile, the works will be heavy. The deepest excavations, however, will be principally in gravel and boulders, those in rock will not be so deep. The line crosses six ravines varying from 65 to 90 feet in depth, and from 250 to 600 feet in breadth at formation level, their slopes meeting within a few feet at the bottom.

From 368th to 374th mile the works will be heavy, the greater number of excations will be in rock, the balance in gravel and boulders. Five ravines have to be crossed, varying from 75 to 100 feet in depth, and 400 to 500 feet in width at formation level, their slopes nearly meeting at the bottom.

From 374th to 380th miles the work will be light and moderate, the cuttings chiefly in sand and gravel.

Section 3.— *Boston Bar to Yale,* 380 *to* 403 *miles.*

The works generally on this section will be very heavy, the excavations chiefly in rock including 14 tunnels varying from 200 to 3,900 feet in length, making an aggregate length of about two miles.

Besides the ravines that will require bridging or embankment, the following are the principal streams between Lytton and Yale:

358th mile.—River Fraser, one thousand feet of bridging.

369¼th mile.—River Nah-ah-latch in a canyon 112 feet deep from formation level, and 350 feet wide at top, but on a rock bench 90 feet below formation level, the breadth is 100 feet.

394th mile.—River Spuzzim in a gorge 400 feet wide, at formation level, 80 feet deep; river 100 feet wide and 7 feet deep.

Section 4.—*Fort Yale to Fort Hope,* 403 *to* 418 *miles.*

From Yale the line continues on the right bank of the river, to a point opposite Fort Hope, at the 418th mile. The gradients are variable, and the works will be heavy on the first three miles; on the balance they will be moderate.

ON THE LOWER FRASER.

Section 1.—*Fort Hope to Cheam* 418 *to* 442 *miles.*

The survey of 1872 ends here, and that of 1874, made in connection with the line from Kamloops by the Nicola and Coquihalla Valleys, was carried from Fort Hope down the left bank of the river 47 miles. The engineer in charge having made an exploration of the right bank, found it so unfavourble for railway construction for 40 miles, down to a point below the Harrison River, that he decided to carry the survey on the opposite bank till this difficult country was passed.

The following is extracted from my progress Report of the survey of that year with the mileage, continued from Yellow Head Pass.

The altitude of the Fraser at Fort Hope, at average high water, is approximately 120 feet above sea level, and its banks about 20 feet higher.

For the first mile and a half down to the crossing of the River Quickwolum, the line is on broken side hill ground, but the works will be moderate.

The Quickwolum is an impetuous mountain stream 150 feet wide. Thence to the 422nd mile, the line is on a flat, and the works will be light or medium.

In the next three miles the river washes the base of a precipitous mountain slope along which the line runs sometimes on slides of loose rock or gravel, at others on narrow benches close to the river, so that the excavations would be heavy, and retaining walls at several places would be required to protect the embankments from the wash of the river.

At 424½ miles the line crosses the River Oquisahlus, 130 feet wide.

From 425 to 431 miles, the line traverses a flat, and the works will be light.

At 428½ miles it crosses the River Shalo, a stream 80 to 100 feet wide.

From 431 to 435 miles the bank of the river presents a broken irregular line, the rugged slopes of the Tenas mountain coming down precipitately to the water's edge. The line has, therefore, been taken through a pass at the back of the mountain.

With gradients of 1 per 100 rising on the one side and falling on the other, there would on this section be very heavy rock excavations, and a tunnel estimated 900 feet in length, and even with gradients of 80 feet per mile the excavations would be heavy.

Section 2.—From Cheam to the crossing of the Fraser at St. Mary's Mission 442 *to* 465½ *miles.*

On the next seven miles the ground is undulating, and some of the gradients would be stiff, rising and falling each way. The line passes behind the Indian village of Cheam between the 439th and 440th mile. On this section a number of streams and some rocky spurs are crossed and the works on the average will be rather heavy.

From the 442nd to 457th mile the line runs on a low flat, subject in part to overflows from the Fraser. On the first 9 miles, to the crossing of the Chilliwhack at the 451st mile, the works will be light as the overflow is not deep. The Chilliwhack is 326 feet wide, and 25 feet deep at flood, and for half a mile, crossing the valley of that river the floods rise 5 to 20 feet above the surface. From this up to the 423rd mile, the overflow is not deep, and the works will be moderate.

From 453 to 456½ miles there are a number of sloughs, and the ordinary floods cover the ground to a depth of 5 to 12 feet. The floods of 1876 were much higher, and the embankments would have to be protected throughout, so that the works on this section would be heavy.

At 456½ miles is the crossing of the River Sumas, 300 feet wide and 30 feet deep at flood.

From this point, the line runs along the foot of the Sumas Mountain, the slopes of which for the first two miles terminate precipitously on the Fraser, so that in this length and there would be heavy work excavations, a tunnel about 1000 feet in length; rip-rap, or other projection works would be required.

The next two miles is over a low flat subject to overflow, from 2 to 6 feet in depth, and it is intersected by several small streams.

From 460½ to 462 miles the Fraser again washes the foot of the mountain, and the line is on the rocky slopes, requiring heavy rock excavations, and a tunnel 1,500 feet in length. Thence to the crossing of the river at 465½ miles, the line is on a flat, subject to overflows, and intersected by several sloughs.

The point selected for crossing the Fraser is at St. Mary's Mission, where the breadth of the river is 1400 feet, and its depth at high water 57 feet, with sandy bottom.

Section 3.—From St. Mary's Mission along the right bank of the Fraser 465½ *to* 483 *miles.*

From the crossing of the Fraser, the line was carried for 6 miles on high gravel and clay benches, at some distance from the river, to avoid the low ground subject to overflow; but these benches are so broken with deep lateral gulches, that the works would be very heavy. A line therefore, has been projected, as shown on the plan, along the low ground by the side of the Fraser, to the crossing of the river Stave, at 472¾ miles. A considerable portion of this will be subject to the overflow of the river, and rip-rap, or other projection works will be required.

The Stave is 900 feet wide and 31 feet deep in mid-channel at flood, with a hard bottom of clay and coarse gravel. This river takes the overflow of a large lake, about 12 miles distant, and it is not subject to high floods, nor does it bring down much drift-wood.

From the Stave (472¾ miles,) the line follows the north bank of the Fraser very closely for 10 miles, with easy undulating gradients.

On 8 miles of this the works would be light; on the balance they would be medium.

Section 4.—From the Fraser to Port Moody, 483 *to* 493½ *miles.*

At this point, 482¾ miles, the line leaves the bank of the Fraser and takes an almost direct course for Port Moody, at the head of the east arm of Burrard Inlet.

In two miles, with a descending gradient and moderate works, it reaches Pitt

meadows, which are about five miles wide and subject to an overflow of 2 to 5 feet in depth. They are intersected by a number of sloughs and by the River Pitt. The line crosses this river at a narrow part near the 488th mile, where it is 1,240 feet wide with an extreme depth of 60 feet, the bottom being of clay and sand. It receives the discharge of a large lake of the same name, and has a tidal current of two knots per hour; the tide rises 5 feet.

From the edge of the Pitt meadows, near the 490th mile, the ground continues low and wet for a mile and a half, and is covered with cedar, spruce, fir and alder. It is crossed by the River Coquitlum in seven branches or sloughs; but these could probably be all diverted under one or two bridges.

Thence to the end of the survey at 492½ miles the line runs over a gravel ridge about 100 feet above sea level.

The survey ends within a mile of Port Moody, so that the latter is 493½ miles from Yellow Head Pass. The distance thence to Coal Harbour, just within the first Narrows, as measured on the chart is 13 miles, and to the south side of English Bay 3 to 4 miles more, making a total of 506 miles to Coal Harbour and 510 to English Bay.

Description of the timber on this route.

Near the summit of the Yellow Head Pass the timber is principally small black pine; thence, down to Lake Albreda, 71 miles, it is mixed with spruce and balsam of larger growth; this increases in size as we descend the Albreda Valley to its junction with that of the North Thompson. Thence, down the latter to the mouth of the Clearwater, 80th to 183rd mile, the timber is principally spruce, balsam and cedar of very large growth, with some Douglas fir up on the slopes of the hills.

From Clearwater to Lytton, 183rd to 250th mile, it is chiefly a yellow pine of little value, which grows in clumps or thinly straggling on the dry soil of the Central Plateau—of volcanic formation—with groves of aspen and cottonwood of second growth interspersed.

From Lytton to Fort Hope in the valley of the Fraser, 350th to 420th mile, the timber is chiefly Douglas fir on the slopes, mixed with some spruce and yellow pine.

From Fort Hope to Burrard Inlet there are spruce, balsam, hemlock, cedar, alder and cottonwood on the low grounds, with birch and Douglas fir on the slopes of the mountains. As we approach Burrard Inlet the Douglas fir is of large size and good quality.

The Snow-fall.

An unusual quantity of snow fell in this region in the winter of 1875-6. At the summit of the Yellow Head Pass it was 4 feet deep; at the foot of Moose Lake, where the altitude is 300 feet lower, it was 5 feet; at Tête Jaune Cache, where the altitude is 1,274 feet lower than the summit of the pass, the depth was 3 to 4 feet.

The slope of the valley is very steep and there are indications of snow-slides, so that strongly constructed snow-sheds will be required in some places, but to what extent can only be ascertained from experience to be gained during the construction of the railway.

Down to this point—49 miles—this description applies to all the lines that have been surveyed from the Yellow Head Pass to the Pacific coast.

From Tête Jaune Cache to the mouth of the Albreda, 82 miles, the depth of snow attains a maximum of about 5 feet; thence, it decreases as we descend the valley of the North Thompson till, at the mouth of the Clearwater, it does not exceed 3 feet. Some snow-sheds will probably be required in the canyons of the Thompson, between the Albreda and the Clearwater, where the mountain slopes are very steep, and snow-slides take place.

From the Clearwater to Lytton, 183 to 350 miles, is within the dry zone, and the snow very rarely attains a depth exceeding 2½ feet; but from Lytton to Yale, in the canyons of the Fraser, it is sometimes very heavy, and slides in avalanches down the steep mountain sides. In November, 1875, a heavy snow-storm took place and filled up the escarpments made in the rocky slopes in constructing the waggon road, to a depth of over 20 feet in some places. The snow did not remain long, but such heavy storms are of frequent occurrence in the Cascade Mountains, and snow-sheds will be required occasionally whichever route may be adopted through the same.

LINE No. 6 IN CENTRAL GROUP, FROM YELLOW HEAD PASS TO BUTE INLET.

A trial location survey of this line was completed last season, 1876. It commences on the divide in the Yellow Head Pass at the same point as the line last described and for some distance the two lines are identical.

IN THE ROCKY MOUNTAINS.

Section 1.—*Yellow Head Pass to the foot of Moose Lake* 29 *miles.*

This is identical with section 1, of the line last described.

Section 2.—*From the foot of Moose Lake to Tête Jaune Cache,* 29 *to* 49 *miles.*

From the 29th mile the river descends very rapidly till it reaches Tête Jaune Cache, about the 37th mile a large branch enters from the north, and this point is called the Forks of the Fraser.

The line follows the left or south slope of the valley, which is steep and irregular, in some places at a considerable distance from and height above the river. At the 48th mile it reaches Tête Jaune Cache, and at 49½ miles crosses Cranberry River, a stream 100 feet wide, but in spring freshets overflowing its banks and covering the bottom of the valley to a breadth of 300 feet.

The altitude of the line at this point is 2,459 feet above sea level, making a fall of 955 feet in 20½ miles, averaging 46½ feet per mile. The maximum gradient used is 1 per 100, 52·80 feet per mile, of which there is an aggregate length of 16 miles rising eastward.

At the 30th mile the line enters on a formation of slate rock, which crops up to the surface. This continues tc 35½ miles, between which and the 40th mile the rock is principally granite. Thence on to 47 miles the surface is covered with sand, gravel, and granite boulders, with solid granite protruding at various points; so that on 17 miles of this section the works will be heavy, consisting of deep rock excavations, high embankments, and the bridging of deep ravines, with one tunnel through sand and gravel 700 feet in length, and another 1,000 feet in length, through solid granite. On the balance to Cranberry River, 49½ miles, the works will be light.

The timber near the summit where the line commences is small black pine, but from Yellowhead Lake down to Cranberry River, it is principally spruce and balsam, with some Douglass fir on the slopes of the mountains, all of good size for railway structures, ties, &c.

Section 3—*Tête Jaune Cache to Grand Rapids,* 49 *to* 181 *miles.*

Tête Jaune Cache is nearly on the 53rd parallel of north latitude. Thence the valley of the Fraser takes a north-westerly course, having the main chain of the Rocky Mountains on the right and the Cariboo range on the left. It keeps this course in nearly a direct line to the latitude of 54° 17′, where it makes a great bend to the west, turning the north-west end of the Cariboo range, after which its general bearing is nearly south for a long distance.

The valley varies from two to four miles in breadth; its course is very direct, but that of the river is extremely tortuous, runing from side to side of the valley, between heavily timbered flats and benches of sand, gravel and clay. Some of these are partially submerged at high floods; the others vary from 10 to 300 feet above the level of the river.

The line follows the left or south east side of the valley down to Grand Rapids, at the 181st mile, at which the altitude is 2,065 feet above sea level; and, as it is 2,459 feet at Cranberry River, near the 59th mile, there is a fall 394 feet in 131 miles, an average of about 3 feet to the mile.

The surface of the valley is very irregular, and the line has frequently to rise or fall from one bench to another to avoid land slips and the overflow of the river, and to cut off the sharp bends as far as practicable, so that the gradients are undulating throughout this section, and the maximum of 1 per 100 has been frequently used, making an aggregate length of 8¾ miles rising and falling each way.

The length of the River Fraser, between the mouth of Cranberry River and Grand Rapids, is 185 miles, and the difference of level is 367 feet, an average of barely two feet per mile: the fall is tolerably uniform with a few ripples and rapids not very swift; so that at small cost the navigation of this section of the river could be made good for steamers of light draught which would be serviceable in the construction of the railway.

The River Fraser appears to have been at some remote period dammed up at one or more points about its entrance to the Cascade or Coast Range of Mountains, and at different epochs to have burst through these rocky barriers and fallen to a lower level, forming distinct benches and dunes of alluvial deposit. These are very irregular in form and height, and, in many places, are furrowed by deep lateral gulches, so that the cuttings and embankments in such places will be heavy, but from the nature of the materials, chiefly sand and gravel, the average cost of the works on this section will not be heavy.

The following are the principal streams to be bridged:

66¼ miles.—Kiwa (Crooked River), 100 feet wide, 3 to 6 feet deep; formation level 15 feet above the bed of the river.

83¼ miles.—Shuswap River, a rapid stream, 4 feet deep, 150 feet wide at low water, 18 feet at floods; formation level above bed of river 29 feet.

86 miles.—Castle River, 80 feet wide; formation level, 18 feet above bed of river.

96¼ miles.—River, 150 feet wide, 3 to 4 feet deep, rapid current; formation 23 feet above bed of the river.

102½ miles.—Rapid stream, 30 feet wide, formation above bed, 7 feet.

109½ miles.—Rapid stream, 30 feet wide at low water; at high water it overflows the valley 200 feet wide, to a depth of 3 feet; formation 37 feet above bed of river.

119 miles.—River 200 feet wide, and 4 feet deep at low water; at high water it overflows its banks to a few inches in depth, when it is 12 feet deep in centre; formation level 17 feet above bed of river.

135 miles.—Stream 100 feet wide, 4 feet deep at low water, 11 feet at flood; bed to formation 36 feet.

141½ miles.—Stream 75 feet wide, 5 feet deep at low water, 14 feet at flood, when it overflows its banks 2 to 3 feet; bed to formation, 20 feet.

142¼ miles.—Low flat flooded by back water from the Fraser, requiring trestle work 700 feet long, height from bed to formation level, 28 feet.

The timber on the flats and benches is generally spruce and balsam with cedar of large size; on the slopes it is spruce, cottonwood and birch.

Section 4—Across the Peninsula included within the bend of the Fraser, 181 *to* 228 *miles.*

The Cariboo range, which, near Tête Jaune Cache, is five to six thousand feet above the level of the Fraser valley, diminishes in height as we descend the river, till near the Grand Rapids it is about 2,000 feet; the hills here recede from the river abruptly,

and the peninsula included within the great bend of the Fraser, diminishes gradually from 300 feet above the level of the river to low flats partially covered at high water.

At the Grand Rapids the line leaves the valley of the Fraser and takes a more westerly course along the base of the foot hills of the Cariboo Range, and at the 228th mile it again reaches the Fraser Valley and crosses the river at Canyon Pass, about twenty-one miles above Fort George, and twenty above the mouth of the Stewart.

The altitude of the line at the head of the Grand Rapids (181 miles), is 2,065 feet above sea level; thence, the rise to the plateau of the peninsula is 305 feet, at the 189th mile. In this rise, the maximum gradient is 1 per 100, of which there is an aggregate length of 3½ miles; from this the plateau is slightly undulating to the 208th mile, and the gradients are easy.

The altitude of the last point is 2,315 feet; from this, the line descends by a narrow valley to that of the Willow River which is reached at the 212th mile with a gradient of 1 per 100 for 3¾ miles.

The altitude at 212 miles is 2,110 feet; thence, the descent to the Fraser is nearly uniform, with easy gradients.

The altitude of the line at the crossing of the Fraser (228 miles), is 1,932 feet; and that of the river at highest flood, 1,908 feet. The aggregate length of the maximum ascending gradients on this section, going east is 6·8 miles; going west it is 5·7 miles; the character of the works may be classed thus:—

Light work, 19 miles. Moderate work, 20 miles. Heavy work, 8 miles.

The heavy works are excavations in clay, with a small quantity of rock. Of the 20 miles of work classed as moderate, the excavations will average under six feet in depth, but there is a small quantity of rock in some of them, and in the valley of Willow River a considerable quantity of piling and rip-rap will be required to protect the line from the overflow of the river at very high floods.

The following are the principal streams to be bridged:—

At 205¾ miles the Bear River is crossed at a canyon 200 feet deep, and will require a bridge of one span of 260 feet across the chasm, with some bridging 70 feet high in approaches.

There are three crossings of the Willow River, the channel of which is 200 feet wide and 7 feet deep at the centre, but at high floods the banks are overflowed to a depth of 2 to 3 feet. To give free passage to drift timber, three spans of 100 feet, will be required at each crossing; the mean height from bed of stream to formation level, at the first crossing, is 12 feet; at the second 15 feet, and at the third 18 feet.

At Canyon Pass, 228 miles, the River Fraser is confined by a mass of solid granite on each side; the depth at low water is 22 feet, and at the high floods of 1876 it was 39 feet.

The bed is believed to be rock, covered with a thin layer of gravel, and the height to formation level is 62 feet.

The timber on this section is principally spruce and balsam. The greater portion of it is under 12 inches diameter, but larger sizes can be obtained on the slopes. In the valley of Willow River the timber is principally cotton-wood of large growth.

ON THE CENTRAL PLATEAU.

Section 1.—Crossing of the Fraser to the mouth of the Chilacoh, 228 to 257 miles.

The banks of the Fraser from this point, down very nearly to the River Stewart, 20 miles, are high benches of clay and gravel, very much broken and intersected, by narrow deep ravines, and land slides frequently occur during or after high floods; the line has therefore been carried well up the slopes of the valley and across the tongue of high land in the angle between the Rivers Fraser and Stewart.

At 229½ miles, the line crosses the Salmon River, where it is 200 feet wide and 10 feet deep in mid-channel at high floods, when its right bank is overflowed to a

depth of 3 feet. Height from bed of stream to formation level, 20 feet; altitude of the latter, 1,917 feet above sea level.

Up to the 233rd mile, the gradients are easy and the works will be light, but from this point the line commences to rise up on the slopes of the valley with a gradient of 1 per 100 for nearly 4¾ miles, with a short length of level in the middle. At 238¾ miles the altitude is 2,212 feet, where the line begins to descend to the Valley of the Stewart, reaching the bottom flat of that valley at 246 miles and crossing the river at 249 miles, which is here 400 feet wide, 12 feet deep at low water and 22 feet at flood. Height from bed of river to formation level, 63 feet; altitude of the latter, 1,947 feet above sea level.

Thence, the line follows the right or south bank of the Stewart, with easy gradients, to the mouth of the Chilacoh, at 256¾ miles. The total length of the maximum gradients of 1 per 100 on this section rising west is nearly 6¼ miles; rising east it is 3½ miles.

Between the 233rd and 240th miles the works will be heavy, consisting of deep excavations in clay and gravel, high embankments, and bridging numerous deep ravines; on three miles more, 243 to 246 miles, the works will be moderate, and on the rest of the section they will be very light. There are no rock cuttings on this section. The timber on the banks of the River Stewart is principally spruce and small black pine.

The line from Bute Inlet to the mouth of the Chilacoh is described in my report of the surveys of 1875; but a re-survey has been made in the canyons of the Cascade Mountains, and the levels have been corrected. It will be better to continue the present description and mileage through to the coast.

Chilacoh Section, 257 to 290 miles.

The altitude at the junction of the Chilacoh and Stewart valleys, 286¾ miles, is 2,065 feet; thence, the line follows up the Chilacoh valley 33 miles, in which distance the rise is 182 feet, or 5½ feet per mile; but the gradients, though generally easy, are variable, and from the 272nd to the 274th mile, where the line has been carried well up the slopes of the valley to avoid landslips on the river bank, there is a gradient of 1 per 100, two miles in length, rising westwards; and at the 289th mile, where the line drops to cross the river, there is a like gradient, 3,000 feet in length, rising eastward.

On the first three miles the work will be rather heavy, some of the cuttings running over 30 feet in depth, but these are short and generally in sand and gravel; only three of them are in loose rock.

From the 260th to the 272nd mile the excavations and embankments will be very light, but there will be several diversions of the river, making an aggregate length of 4,000 feet, and three crossings of the same, each requiring a bridge of one span of 100 feet, with some shorter spans in the approaches. On the next five miles the excavations will be rather heavy, but chiefly in sand and gravel.

From 277 to 289 miles, the works will be light, but on the next mile the line crosses the valley, requiring an embankment 2,200 feet in length, and 30 feet high, and a bridge giving a clear opening of 100 feet. The altitude of formation level at this point is 2,237 feet.

Section 2—Across the divide, between the Chilacoh and the Blackwater, 290 to 312 miles.

The line ascends the slope of the divide, between the Chilacoh and the Blackwater, by a serpentine course, and reaches the plateau at 299 miles, where the altitude is 2,598 feet. In this length, there are two gradients of 1 per 100, aggregating 5½ miles, with stretches of level and easy gradients between them.

There are four ravines to be filled up or bridged; the largest of these is 110 deep, 500 feet wide at the top, the slopes meeting at the bottom.

The smallest is 60 feet deep, breadth at top 300 feet, the slopes meeting at the bottom.

From 299 miles, the line takes a direct course across the plateau, to the valley of the Blackwater, which it reaches at 308 miles, with easy undulating gradients, crossing the telegraph line* near the 302nd mile, at which the altitude is 2,683 feet. The work on this length will be light. The formation is sand, gravel, and boulders, and there will be no deep cuttings.

From the 309th mile, the line descends obliquely the steep slope of the valley of the Blackwater, with a gradient of 1 per 100, reaching the bottom flat at the 312th mile. On this length there will be some heavy rock side-hill cuttings, and two tunnels in volcanic rock, one 600 feet, and the other 1,300 feet in length.

The timber between the Chilacoh and the Blackwater, is principally small black pine on the high grounds, mixed with a small quantity of Douglas fir of large growth. On the low grounds, it is principally spruce and cotton-wood.

Section 3, *Blackwater Valley,* 312 *to* 327 *miles.*

The altitude at 312 miles is 2,542 feet; thence, the line follows up the valley of the Blackwater to the mouth of the Nazco, at the 327th mile, where the altitude is 2,680 feet, making a rise of 138 feet in 15 miles; but a portion of the valley is narrow and crooked, and to avoid heavy works, the maximum gradient of 1 per 100 has been used for one mile in length rising eastward.

A length of about four miles of this section is on a formation of volcanic rock, and the cuttings will be rather heavy; the balance is principally on gravel and boulders, with rock underlying.

The line crosses the river three times. *First,*—At 317½ miles, where the breadth of the river is 200 feet, depth 12 feet at flood, height from bed to formation level 46 feet. *Second,*—At 318¼ miles; breadth at flood 300 feet; depth 10 feet; height from bed of river to formation level 42 feet. *Third,*—At 320 miles; breadth at flood, 150 feet; depth 7 feet; bed of river to formation level 17 feet. The timber on this section is small black pine, cottonwood and spruce on the lower grounds; on the high slopes it is Douglas fir and yellow pine.

Section 4—*The lower portion of the Nazco Valley,* 327 *to* 370 *miles.*

The Nazco, from its mouth to the foot of the canyon at the 370th mile, is a fine open valley with extensive natural meadows on the banks of the river, interspersed with groves of spruce, black pine and cottonwood, generally of small growth; Douglas fir and yellow pine are thinly scattered on the slopes.

The altitude at the mouth of the Nazco is 2,680 feet, and at the foot of the canyon 2,990 feet, giving a rise of 310 feet in 43 miles; so that the gradients throughout are easy, the highest being 0.5 per 100, 26.40 feet per mile.

On some portions of this section there will be rock cuttings, more especially on the shore of Lake Nazco, from 364 to 368 miles. But the line has been run to shorten distance as much as practicable, and to keep off the low lands which are subject to overflow; so that there are points at which it may be found desirable to make short deviations in order to reduce the quantity of rock excavations. The balance of the works will be light.

The line crosses the Nazco seven times; the two lower crossings are 200 feet wide, 9 to 12 feet deep at flood, and the height from bed of river to formation level 22 feet. The next four crossings are 128 feet wide, 8 to 12 feet deep at flood, and 20 feet from bed to formation level. The last crossing is 100 feet wide, 10 feet deep, and 22 feet from bed of stream to formation level.

---

* The telegraph trail here alluded to, was made by the Western Union Telegraph Co., in 1865, with a view of establishing telegraphic communication with Europe, *via* Alaska and Russian territory; but was abandoned on the successful completion of the Atlantic Telegraph Cable, in 1866.

Section 5.—*Nazco Canyon,* 370 *to* 378 *miles.*

From 370 to 378 miles the line is through the Nazco Canyon, with an almost continuous gradient of 1 per 100, and with curves of 5,730 feet to 1,433 radius. The upper part of the canyon is composed of basaltic rock; the lower part is conglomerate.

There will be heavy rock cuttings throughout the canyon, and a bridge of a 100 feet span over the river; height from bed to formation level 42 feet.

Section 6.—*On the Plateau between the Nazco and Chilicotin Rivers,* 378 *to* 407 *miles.*

The course of the line is now S.S.W. along the margins of Lakes Tchusiniltil, Zazatee and Nestachee, with easy undulating gradients; the altitude near the west end of the last lake, at 384 miles, is 3,475 feet. Thence, the line takes a south-westerly course across the plateau to the Chilicotin Valley, crossing the river at the 407th mile near the foot of Chisicut Lake. The altitude of this point is 3,295 feet at formation level, which is 58 feet above the bed of the river.

The gradients over this length of 29 miles are undulating and easy, except in descending the slope of the Chilicotin Valley, where there are two lengths of 1 per 100, aggregating 1¾ miles, with a long stretch of level between them.

The whole of this section is over an arid country of sand, gravel and boulders, and the works will be very light.

From this point, the line takes a general southerly course, ascending the western slope of the Chilicotin Valley obliquely with easy gradients, the maximum being 0·85 per 100, or, 4·88 feet per mile for a mile and three-quarters in length. It reaches the highest point of the plateau which divides the Chilicotin Valley from the basin of Lake Puntzee, at the 413th mile, where the altitude is 3,472 feet. From the 416th mile the line descends obliquely the western slope of the basin of Lake Puntzee, reaching the head of the lake at the 423½rd mile, and thence follows a narrow pass into the valley of the Chilancoh, crossing the river at 427½ miles, which is here 39 feet wide. The height from formation level to the bed of the river is 37 feet altitude at formation; by revised surveys, 2,985 feet above sea level.

On the whole of this section the aggregate length of the maximum gradient of 1 per 100 is two miles rising eastwards, the maximum rising westwards is 0·85 per 100 for 1¾ miles.

On eight miles of this section there will be rather heavy cuttings and embankments, chiefly in gravel and boulders, with solid rock cropping up at a few points; on the balance the works will be moderate.

The timber is chiefly small black pine, interspersed with a small proportion of Douglas fir of better quality.

Section 7—*The Chilancoh to the Summit of the Divide,* 407 *to* 452 *miles.*

From the Chilancoh the course of the line is south-west, ascending, by a depression, what appears to be the ancient bed of a river to the level of the plateau with stiff gradients, of which there are two lengths of the maximum of 1 per 100, making together 4½ miles. At 442 miles the altitude is 3,450 feet above sea level. Thence, the line follows the same depression in the plateau with easy undulating gradients to 452 miles, where it reaches the summit or divide from which the waters flow eastward to the Fraser, and westward to Bute Inlet. The altitude of this point is 3,505 feet.

This section, from the Chilancoh, 427½ miles, to the head of Eagle Lake, 444½ miles, is broken with ridges of sand, gravel and boulders, and indented with hollows and dry beds of ponds. The works will not be heavy till after reaching Eagle Lake, along the shore of which, seven miles in length, there will be a considerable quantity of rock cutting.

The country is of the same character as that east of the Chilancoh; the timber being principally small black pine in the valleys, with Douglas fir of fair size and quality on the adjoining hills.

IN THE CASCADE MOUNTAINS.

Section 1.—*Watershed to the foot of Lake Tatlayacoh*, 452 *to* 484 *miles.*

From the summit, the line descends the valley by a stream and series of small lakes on a course generally south to 471½ miles, where it reaches the shore of Lake Tatlayacoh, about 2½ miles from its head. The altitude at this point is 2,760 feet, and that of the Lake 2,717 feet; the gradients are continually descending from the summit, and there is an aggregate of 11 miles of the maximum of 1 per 100.

The line now follows the eastern shore of Lake Tatlayacoh in the same southerly direction, to its outlet at 484 miles, with easy undulating gradients.

From the summit at 452 miles to 463½ miles, the works will be light, the cuttings not deep, and principally in gravel, sand and boulders, with some loose rock.

The heaviest works will be in the crossing of two ravines, one 114 feet deep and 500 feet wide at the top, the other 113 feet deep and 400 feet at top; in both, the slopes meet within a few feet at the bottom.

At 463½ miles the line is entering into the Cascade Mountains, and the works from this point to the outlet of Lake Tatlayacoh will be heavier, as a large portion of the excavations will be in rock, though they will not be deep, except for a mile at the foot of the Lake.

At 481 miles the line crosses the Chesee River, a glacial stream 100 feet wide, rapid, but not deep.

The timber on the slopes of the valley is principally Douglas fir, and on the shore of the lake there is a considerable quantity of good size and quality.

Lake Tatlayacoh collects the numerous streams that flow down the sides of the mountains; and its outlet, at 484¼ miles, is the east branch of the Homathco.

Section 2—*Lake Tatlayacoh to the head of the Homathco Canyon*, 484 *to* 496 *miles.*

Here we are fairly into the Cascade Mountains and the Homathco valley; from this, down to the foot of the Waddington canyon, at 516 miles, is very contracted.

The altitude of the line at the outlet of the lake (484¼ miles) is 2,728 feet; and from this point it descends 514 feet in 11½ miles, equal to 44·7 feet per mile; the altitude at the 496th mile being 2,214 feet. But the descent is not uniform, there being a maximum gradient of 1·5 per 100, equal to 79·2 feet per mile, for a mile and a quarter; one mile of 1·25 per 100, equal to 66 feet per mile; 1.32 miles of 1·10 per 100, equal to 58 feet per mile; and 2.2? miles of 1 per 100; 0.67 miles level. The balance from 0·20 to 0·76 per 100.

On this section, there will be four miles of heavy rock excavations and several diversions of the river, three miles not quite so heavy, and the balance will be moderate and light work.

The Homathco River, near the outlet of the lake, is 100 feet wide, five feet deep at flood, and the bed of the stream 23 feet below formation level. At the 488th mile the line crosses Ottarasco River, a glacier fed stream 100 feet wide; height from bed of stream to formation level 18 feet.

Section 3—*Through the heart of the Cascades Mountains*, 496 *to* 516 *miles.*

From the 496th to the 516th mile, through the heart of the Cascade Mountains, the valley is contracted to a narrow deep ravine, the rocks of the mountain slopes in many places abutting on the river, and forming canyons through which the river dashes impetuously, carrying down boulders and detritus from the mountains.

The following are the gradients given consecutively :—

Length in miles.	Rate per 100.	Rate per mile.
0·85	1·60	84·48
1·27	2·00	105·60
1·14	1·65	87·12
0·51	Level	
6·67	2·00	105·60
0·70	Level	
4·43	2·00	105·60
0·49	1·47	77·61
0·93	0·90	47·46
3·03	1·15	60·72
20·02		

A great portion of the works on this section will be very heavy, consisting of deep rock excavations and high embankments, and a number of tunnels, a list of which is given below.

From 496 to 500 miles the line cuttings will not be heavy, but materials will have to be found to make up the embankments, the quantity of which will considerably exceed that of the cuttings. At several points, heavy rip rap or other works will be required to protect the embankments from the wash of the river at high floods.

From 500 to 506 miles, the rock excavations will be very heavy, and will supply material sufficient for the embankments. The line is here a considerable distance from the river and no protection works will be required. From 506 to 507 miles the works will be very moderate—chiefly light cutting and embankments. From 510 to 516 miles the rock excavations will be heavy, with several tunnels through rock.

List of Tunnels.

	Feet in Length.
At 497½ miles	100
500¾ do	150
500¾ do	250
501¼ do	200
502 do	500
504 do	950
505¼ do	680
513¼ do	680
515 do	1100
515 do	1800
Total	6350

The streams to be bridged over on this section are rapid mountain torrents, fed from the melting snow and glaciers; their breadth and depth are given approximately at high flood, the breadth being taken at the surface of the water; but the channel often narrows to a few feet at the bottom, especially when in rock.

499½ miles.—River Nude, 75 feet wide, 10 feet deep; height from bed to formation level of railway, 20 feet.

500½ miles.—River Cache, very rapid, 75 feet wide, shallow and overflows its banks, which, near the line, are formed by the detritus brought down by the stream. It will have to be diverted, and the works protected from snow-slides for 400 feet in length.

500¾ miles.—Stream in a rocky gorge, 70 feet wide, and 37 feet from bed of stream to formation. Snow slides down this gorge, and last year it was nearly filled up, the fall being unusually heavy.

507 miles.—West branch of the Homathco River, near the junction of the two branches, in a canyon between solid rocks, 140 feet deep from formation level to the bed of the stream. It will require one span of 150 feet, with piers 60 feet high, with 200 feet trestle or bridging of small spans at each end 10 to 50 feet high.

$507\frac{1}{2}$ miles.—Teideman's Glacier River is 160 feet wide, 8 feet deep, with rapid current; height of bed of stream to formation level, 40 feet.

$512\frac{1}{4}$ miles.—Rapid stream, 20 feet wide, 2 feet deep.

The timber from the outlet of Lake Tatlayacoh ($484\frac{1}{4}$ miles) to the foot of the Waddington Canyon at 516 miles, is Douglas fir, hemlock and cedar, with a sprinkling ot spruce and white pine, all of good size and quality, especially the Douglas fir, of which there are large quantities upon the slopes and elevated flats among the mountains.

Section 5—*Lower Valley of the Homathco to Waddington Harbour at the head of Bute Inlet*, 516 *to* 546 *miles.*

From the foot of the canyon the Homathco valley widens out to from one to two miles in breadth, its course is tortuous, but the general direction is nearly south.

The river is a turbid, rapid stream in the summer months when it is swollen by the melted snow from the mountains. Its breadth at the foot of the Waddington canyon, 516 miles, is about 150 feet, but in its descent to the sea it frequently devides into two or more branches enclosing low alluvial islands of gravel and light soil, covered with cottonwood, spruce and cedar.

The river in winding through the valley alternately washes the base of the rocky slopes on either side and enters Bute Inlet on the west side of the valley, where the river is fully 300 feet wide.

The line is located on the west side of the valley, and the gradients are generally easy, the altitude at the foot of the canyon being 525 feet, of the river 460 feet, and at the inlet, 10 feet above sea level, giving a fall of 516 feet in 30 miles. But the gradients are not uniform, as the line at several places has been carried well up the slopes to keep the works secure from the action of floods, and the maximum gradient of 1 per 100 falling westward has been used to an aggregate length of about 4 miles.

The line runs alternately on alluvial flats or low benches where the works will be light, then on the face of the rugged rocky slopes of the mountains where the river washes its base. On this there will be a considerable quantity of rock excavation and the works will generally be heavy.

The aggregate lengths of these alternate sections are:—

Eight miles on which the cutting will be principally in rock, and the works on the average rather heavy; 8 miles excavations in sand and gravel, works moderate; 14 miles on low flats, where the embankment will be formed from side-ditches, and the works will be very light.

The rock excavations on this section can be greatly reduced, as the line has been run to keep the works entirely out of the reach of the floods of the river; but it might be thrown closer to the river, and the rock from the excavations used for protection works; or the rock cuttings might be altogether avoided by bridging the river three or four times; but this has not been thought advisable, as the current is very strong at high floods, the fall above tide-water averaging 25 feet per mile, and at every flood great quantities of timber are brought down.

The principal streams to be bridged are:—

$516\frac{3}{4}$ miles—Rapid stream, 80 feet wide, 5 feet deep at flood. Height from bed to formation or grade level, 19 feet.

$518\frac{1}{2}$ miles—Branch of Little Bella Coola, 90 feet wide, and 5 feet deep, height to formation, 18 feet.

Main branch—200 feet wide, 7 feet deep. Height from bed to formation level, 18 feet. This stream has brought down a large quantity of gravel and boulders from the mountain, raising its bed above the level of the valley, and dividing it into several channels.

$521\frac{1}{2}$ miles—Rapid stream, 100 feet wide, and 10 feet deep. Height 16 feet from bed to formation level.

$525\frac{1}{4}$ miles—Stream 60 feet wide, 6 feet deep. Height from bed to formation, 9 feet.

$529\frac{3}{4}$ miles—Stream 100 feet wide, 50 feet deep. Height from bed to formation, 14 feet.

544 miles—Homathco River, 200 feet wide, 20 feet deep at high tide. Height from bed to formation, 32 feet.

The timber on this section is Douglas fir, and spruce of large size and good quality; a great quantity of very large cedars, up to 12 feet diameter, generally hollow in the centre; with cottonwood and alders on the islands.

LINE No. 8 IN NORTHERN GROUP.

FROM YELLOWHEAD PASS TO DEAN CHANNEL.

This line would naturally branch off from the last described (No. 6) at the con fluence of the rivers Nazco and Blackwater, 327 miles from Yellowhead Pass, and follow up the Blackwater Valley with very easy gradients; but to avoid some heavy works and shorten the distance, it diverges from Line No. 6 at a point in the Chilacoh Valley, 280 miles from Yellowhead Pass; and taking a westerly course over a rolling country it enters the Blackwater Valley at a considerable distance above the mouth of the Nazco, and follows it to its head; thence it crosses the divide to the Valley of the Salmon River, which it follows through the Cascade Mountains to Kamsquot Bay on the Dean Channel.

ON THE CENTRAL PLATEAU.

Section 1—*Chilacoh Valley*, 280 *to* 294 *miles.*

The altitude at the starting point (280 miles) is 2,212 feet above sea level, and for the first ten miles the gradients are almost continually ascending westwards to reach the crown of a high tongue of land included within a sharp bend of the River Chilacoh. The altitude of this point (290 miles) is 2,608 feet, giving an average gradient of 29·6 feet per mile, but that of 1 per 100 has been used in two places, making together a length of nearly four and a half miles.

Thence, the line descends to the upper part of the Chilacoh Valley, crossing the river near the 294th mile, at which the altitude at formation level is 2,399 feet. In this descent the maximum gradient of 1 per 100 has been used, for nearly a mile in length.

Up to this point the works will be moderate, the excavations being chiefly in sand and gravel; no rock appears on the surface or on the banks of the river.

The river Chilacoh at this crossing is 100 feet wide, but it overflows its banks, and at high flood it is 200 feet wide, and 13 feet deep at mid channel. Height from the bed of the stream to formation level of railway, 45 feet.

The timber on this section is principally small black pine under one foot in diameter, much of it burnt. In the Chilacoh Valley, there is a large quantity of spruce of good size and quality. High up on the slopes and on the crown of the plateau Douglas fir is thinly scattered.

Section 2—*Chilacoh to the Iscultaesly*, 294 *to* 318 *miles.*

The line follows the Chilacoh Valley on a westerly course 5 miles, thence southwestwards by a lateral valley and a low pass on depressions in the hills to the valley of the Iscultaesly.

It reaches the summit of the divide at the 303th mile, where the altitude is 2,954 feet; an ascent of 555 feet in 14 miles. The maximum gradient of 1 per 100 is used in 4 separate lengths, aggregating $4\frac{1}{2}$ miles.

From the summit the line keeps the same south-westerly course in an almost direct line over a rolling country crossing the river Natanicoh, a stream 25 feet wide, near the 315th mile, and the river Iscultaesly at the 318th mile, near the foot of a small lake, where it is 150 feet wide at floods and 5 feet deep. Height from the bed of the stream to formation level, 50 feet.

The altitude at this point is 2,795 feet, showing a fall of 159 feet in 10 miles. On this there are three lengths of the maximum gradient of 1 per 100 falling westward, making an aggregate of 3 miles. The timber on this slope is small black pine.

The excavations on this section of 24 miles, between the Chilacoh and Iscultaesly, will on the first half be heavy but chiefly in gravel, with a small proportion of rock; on the other half they will be moderate and chiefly in gravel.

Section 3.—*Iscultaesly to Blackwater Valley*, 318 *to* 330 *miles.*

From the Iscultaesly (318th mile) the line follows a generally westerly course across the divide between that river and the Blackwater, reaching the crown at 324 miles where the altitude is 3,241 feet. In the first two miles the rise is 62 feet, and in the next 4 miles it is 384 feet, a rate of 96 feet per mile rising westwards. Thence, on the same course, it descends obliquely the slope of the valley of the Blackwater, reaching the bank of the river at 330 miles; altitude, 3,056 feet.

On this length there is a gradient of 1 per 100 for three-quarters of a mile; the rest being very easy.

The works on this section will be moderate, the excavations chiefly in sand and gravel. The timber is black pine of fair size, with groves of cottonwood on the slopes, mixed with Douglas fir of good size.

Section 4—*Blackwater Valley*, 330 *to* 379 *miles.*

From the 330th mile the line follows up the north branch of the Blackwater on a general course nearly due west, and crosses the river near the 356th mile, where the altitude is 3,139 feet. Thence it follows the south side of the valley up to the 379th mile, where it re-crosses the river. The altitude at this point is 3,362 feet.

The river between these points expands at intervals, forming a series of narrow lakes, the principal of which are Kluscoil, 5 miles in length; Euchinico, 9 miles; Kushia, 5 miles, and Thrascha, 11 miles.

The slopes on the north side of the valley, which are more exposed to the sun, have a park-like appearance. They are covered with bunch-grass and wild pea-vine, interspersed with groves of aspen and straggling Douglas fir. The other side of the valley is more densely timbered with spruce of good size on the lower grounds, black pine, aspen and Douglas fir on the slopes.

The gradients on this section of 49 miles will generally be easy, the rise being 306 feet. There is only one piece of 1 per 100, a mile and a half in length on a rapid part of the river. The works will be moderate throughout, the heaviest being on the shore of Lake Thrascha near its outlet. It would improve the gradients, reduce the works and avoid two crossings of the river if the line were carried altogether on the north side of the valley. The river at flood is 150 feet wide and five feet deep.

Section 5—*The Upper portion of the Blackwater Valley,* 379 *to* 403 *miles.*

From the 379th mile the line keeps the same general course on the north side of the valley to the Forks at 389 miles. The main branch comes from a snow-clad mountain to the south-west, but the line follows the branch from the west which flows out of Lake Eliguck at 398 miles, altitude 3,575 feet. Thence it runs north-westwards along the north shore of the same, 3 miles to its head, and follows the same course two miles at the foot of a range of basaltic columns along the north shore of a small lake, which is the highest source of this branch of the Blackwater; at 403 miles it reaches the summit of the divide between the Blackwater and Salmon Rivers, the altitude of which is 3,660 feet, giving a rise of 298 feet in 24 miles. The gradients are undulating but generally easy. The works throughout this section of 24 miles will be light.

Section 6—*On the Crown of the Plateau,* 403 *to* 417 *miles.*

From this point the line makes a serpentine course by a chain of small lakes on the plateau, with easy undulating gradients touching Lake Gatcho, one of the largest, at 414 miles, altitude 3,495 feet, and reaches Lake Lilly at 417 miles, where the altitude is 3,510 feet.

The works on this section will be moderate, the cuttings chiefly in gravel with a small proportion of rock.

Section 7—*Salmon River Valley,* 417 *to* 435½ *miles.*

From this point the line begins to descend to the valley of the River Salmon reaching the bottom near the river at 431½ miles, altitude 3,017 feet, making a fall of 493 feet in 14½ miles, with variable undulating gradients, of which there are four lengths, of a maximum of 1 per 100, aggregating 8½ miles.

Thence, the line follows the right or north bank of the river with easy descending gradients to 435½ miles, where it crosses the river. The altitude at this point is 2,985 feet; breadth of the river 200 feet; depth at high water, 13 feet; height from bed to formation level, 40 feet.

The works on this section will be light and moderate, the excavation will be chiefly in gravel, with a small proportion of rock. The timber is small black pine, poplar and spruce.

IN THE CASCADE MOUNTAINS.

Section 1—435½ *to* 474¼ *miles.*

Here the line enters the foot hills of the Cascade Mountains, and the valley becomes very narrow, till at 437½ miles it contracts to a rocky canyon, and the river falls so rapidly that the line can no longer follow its bank: it is therefore carried along the rugged slopes of the hills high above the river for six miles, where it takes a more southerly course by a chain of small lakes in a parallel valley. It re-enters the main valley at the 448th mile, and gradually descends to the river, which it re-crosses at 454¾ miles, near Yal tesse or the Salmon House.

At this point, the line enters the Superior ranges of the Cascade Mountains, and follows the right bank of the river to the head of canoe navigation at 470¼ miles where it again crosses the river and follows the left side of the valley to the 486th mile. There it recrosses in a canyon, and reaches tide water in Kamsquot Bay at 488 miles from Yellowhead Pass.

The altitude at 435½ miles is 2,985 feet, and thence to 438 miles the gradients are undulating and easy, the altitude at the latter point being 3,020 feet. From this point the following gradients are given consecutively:—

Feet.		Miles.		Rate per 100.		Feet per Mile.
3,000	......	0·57	......	0·80	......	42·24
9,000	......	1·71	......	1·60	......	84·48
21 400	......	4·05	......	1·70	......	89·76
1,000	......	0·19	......	Level.	......	....
3,340	......	0 63	......	1·00	......	52·80
1,950	......	0·37	......	Level.	......	....
11,700	......	2·21	......	2·018	......	106·59
700	......	0·13	......	Level.	......	....
36,000	......	6·81	......	2·10	......	111·00
770	......	0·15	......	Level.	......	....
24,598	......	4·66	......	1·35	......	71·28
1,882	......	0·36	......	Level.	......	....
11,000	......	2·08	......	1·10	......	58·08
5,800	......	1·10	......	0·88	......	46·46
30,200	......	5·72	......	1·00	......	52·80
5,000	......	0·95	......	0·40	......	21·12
2,000	......	0·38	......	1·00	......	52·80
3,900	......	0·74	......	Level.	......	....
3,000	......	0.57	......	0·80	......	42·24
4,000	......	0·76	......	1·40	......	73·92
1,850	......	0·35	......	Level.	......	....
3,500	......	0·66	......	1·00	......	52·80
250	......	0·05	......	Level.	......	....
5,000	......	0·95	......	1·50	......	79·20
189,340	......	36·15				

Section 2—474½ *to* 486 *miles, to Terminus at Kamsquot Bay.*

The last of the steep gradients ends at 474¼ miles, where the altitude is 425 feet above sea level, and that of formation at the términus 10 feet, making a fall of 415 feet in 13¾ miles. The descent is continuous, with variable gradients, there being five lengths of the maximum of 1 per 100, making together 3¾ miles. The rest of the gradients are easy, with a considerable proportion of level.

The works on these two sections of 52 miles through the Cascade Mountains, may be divided as follows:—18 miles of very heavy work, chiefly deep cuttings in rock, embanking and bridging deep ravines, and a number of tunnels through rock.

These heavy works are chiefly between the 438th and 456th mile, and in the short canyons between the 485th and 486th mile, and include the following:—

List of Tunnels.

No. 1,	at	447½	miles,	length	....	1,300 feet
" 2,	"	448	"	"	....	330 "
" 3,	"	448½	"	"	....	1,750 "
" 4,	"	449	"	"	....	1,600 "
" 5,	"	450½	"	"	....	770 "
" 6,	"	450¾	"	"	....	300 "
" 7,	"	451¼	"	"	....	400 "
" 8,	"	451½	"	"	....	750 "
" 9,	"	452¾	"	"	....	1,050 "
" 10,	"	455½	"	"	....	2,250 "
" 11,	"	456¼	"	"	....	800 "
" 12,	"	462	"	"	....	1,000 "
" 13,	"	465½	"	"	....	560 "
" 14,	"	486	"	"	....	370 "
						13,230 feet
				Equal	....	2·55 miles

The principal bridges that will be required are :—

At $438\frac{1}{4}$ miles.—River Punchusco, a rapid stream, in a gorge 92 feet deep, 400 feet wide at top, 160 feet at bottom.

$440\frac{1}{4}$ miles.—Ravine 120 feet deep, 600 feet wide at top, sloping to a few feet at bottom.

448 miles.—Ravine 200 feet deep, 700 feet wide at top, and a few feet wide at bottom.

$448\frac{3}{4}$ miles.—Ravine 150 feet deep, 200 feet wide at top, 20 feet at bottom.

$450\frac{1}{4}$ miles.—Ravine 125 feet deep, 200 feet wide, on a bench 35 feet below formation level of railway.

$454\frac{3}{4}$ mlies.—Second crossing of the Salmon, gorge 150 feet deep, 600 feet wide at top; 200 feet wide at bench, 85 feet below the formation level of the railway.

$470\frac{1}{4}$ miles.—Third crossing of the Salmon; formation of railway to bed of river, 68 feet, requiring 700 feet of bridging over the river, and 800 feet in approaches 40 feet high.

$472\frac{1}{2}$ miles.—Snow-slide in ravine 25 feet deep, requiring a bridge of one span of 200 feet.

$473\frac{1}{4}$ miles.—Snow-slide in ravine 28 feet deep, will require bridge of one span of 200 feet.

486 miles.—Third crossing of the Salmon in canyon 80 feet deep, 175 feet wide. Will require a bridge of one span of 175 feet.

The curvature on this section is 47 per cent. of the whole ; the sharpest curve is 955 feet radius.

The timber is chiefly spruce, cedar and cottonwood of large size on the flats, and Douglas fir of good size and quality on the slopes ; all increase in size in descending towards the sea.

Kamsquot Bay is six miles from the head of Dean Inlet, and is well sheltered from the strong winds blowing up and down the valley.

It has a frontage of over two miles in length, well suited for wharfage, and well sheltered, but only a narrow belt parallel to this for anchorage, as the water at a short distance from the shore becomes very deep.

The Indians told us that ice forms from the head of the inlet down to this bay, and is sometimes sufficiently strong on the bay itself to bear a man's weight ; but never below it.

ALTERNATIVE LINE FROM THE CHILACOH TO THE CASCADE MOUNTAINS

This branches off from the line No. 6 near the junction of the valleys of the Nechacoh and Stewart, 256 miles from Yellowhead Pass, and follows up the right bank of the Stewart in a westerly direction to its confluence with the Nechaco at the 291st mile. The formation at the starting point is 2,003 feet above sea-level, and about forty feet above the Stewart; while at the 291st mile the formation is about forty-five feet above the river, and 2,133 above sea level; giving a rise in thirty-five miles of only $3\frac{3}{4}$ feet per mile, but the gradients are undulating and there are two miles of 1 per 100 rising westwards.

The works on this section will be moderate, the excavations being principally in gravel.

The principal streams to be bridged are the Chilacoh at the 257th mile; 150 feet wide, and a stream fifty feet wide at the 263rd mile.

From the junction of the Stewart and Nechaco Rivers, the valley of the latter takes a bend to the north-west; to avoid this the line crosses over the plateau in a south-westerly direction.

From the 291st mile the line follows up the Valley of the Nechaco to the 303rd mile, where it commences to ascend the hill-side, and at the 304th mile enters the Valley of Tsinkut Creek, which it follows to Tsinkut Lake at the 311th mile. Elevation of Lake, 2,385 feet, and formation, 2,438 feet above sea-level.

In this distance of twenty miles, the rise is 305 feet, with varying gradients; there are two miles of 1 per 100 rising west.

About four miles of this section will have heavy works, including ½ mile of protection near the 291st mile, where the toe of the bank touches the river. The balance of the works will be light.

There is a stream fifty feet wide to be bridged at the 294th mile, and Tsinkut Creek, seventy-five feet wide, at the 307th mile.

From the outlet of Tsinkut Lake, the line passes along the north sides of that and Nodki Lake, and to the south of Tachick Lake. It then crosses a rolling plateau, to the 332nd mile, where it reaches an elevation of 2,722 feet above sea level, and enters the valley of a stream fifty feet wide, flowing south-westwards to the Nechaco.

The gradients on this section are undulating, with four miles of 1 per 100 rising west, and 1½ mile rising east.

On about six miles the works will be heavy, and on the remaining fifteen they will be light.

At the 318th mile, Stoney Creek has to be bridged; it is 150 feet wide, but very shallow, and the bottom covered with boulders.

Between the 311th and 324th miles, the telegraph trail is crossed and recrossed several times.

After passing the summit at the 332nd mile, the line ascends the valley of the creek above-mentioned for twelve miles, and again enters the valley of the Nechaco at the 344th mile. The elevation of formation at this point is 2,443 feet above sea level, being a descent of 274 feet in twelve miles; but as most of this has to be made between the 335th and 339th miles, a gradient of 1 per 100 is required for about four miles on this section there will be four miles of heavy work, and eight of medium. A stream 75 feet wide, is crossed at the 339th mile.

On entering the valley of the Nechaco at the 344th mile, the formation is about 100 feet above the level of the river. The line then runs in a south-westerly direction along the face of the side-hill, in some places two or three miles back from the river, to the 362nd mile, where it again approaches it; elevation of formation, 2,664 feet above sea level.

The gradients on this section undulate, and include 2¾ miles of 1 per 100 rising west; and 1¾ miles rising east.

There will be six miles of heavy works and 12 of medium, with very little rock. One ravine has to be crossed 80 feet high and 1,000 feet wide. It is probable, however, that the gradients could be improved, and the work reduced by running the line on low benches close to the Nechaco River. The river flows through a canyon for 5 miles above this, and it was found necessary to run the line on the side hill sometimes upwards of 200 feet above the stream, as far as the 370th mile.

The gradients on this portion are easy and undulating, and the works will be moderate, the cuttings being principally in gravel. There are no streams of importance to be bridged, but one ravine has to be crossed 110 feet deep and 1,000 feet wide.

At the 370th mile the formation is 2,651 feet above sea level, and about 60 feet above the river. The line keeps close to the river, and follows it up to Nahtaleus Lake at the 387th mile, where the elevation of formation is 2,665 feet above sea level.

The gradients are easy and undulating, and the work will be moderate, there being only a small percentage of rock. About one mile of protection work will be required, but it is probable this could be avoided if a revised survey were made.

At the 370th mile a stream 50 feet wide is crossed, and another of the same size at the 380th mile.

The elevation of Nahtaleus Lake is 2,658 feet above sea level, and the line skirts along its south-eastern shore to the 393rd mile with easy undulating gradients; the works will be rather heavy. The cuttings are principally in gravel, but some protection works will be required on bays of the lake.

There are no streams of any consequence to be crossed on this length.

After leaving Nahtaleus Lake, at the 393rd mile the line follows up the Entiaco River, reaching Entiatetachuck Lake at the 408th mile--elevation 2,981 feet above sea level, showing a rise in 15 miles of 323 feet--but on account of canyons on the river, undulating gradients have to be used, including 6 miles of 1 per 100 rising west, and 1 mile rising east.

The excavations will be heavy, and generally in rock.

The Entiaco River, 100 feet wide, is crossed 15 times, and will probably require to be bridged thirteen times.

From the 408th mile the line follows the north-western side of Entiatetachuck Lake to the 416th mile, keeping well up on the slope to avoid bluffs on the margin of the Lake; and then up the Entiaco River to the 418th mile, where it leaves it. In this distance the gradients undulate, and have 1¼ mile of 1 per 100 grade rising east.

The cuttings will not be leep but a large proportion of them will be in rock.

The Entiaco River is crossed twice between the 416th and 418th miles, but this can be avoided by an alteration of the line.

The divide, between the waters of the Nechaco flowing eastward to the Fraser River and those flowing westward to Dean Channel, occurs at the 430th mile and is 3,100 feet above sea level, the formation at same point being 3,105 feet. The ascent from the 418th mile to the summit is 106 feet, but the line follows a depression in the plateau with undulating gradients and at the 423rd mile attains an elevation of 3,147 feet above sea level. There are two miles of a gradient 1 per 100 rising west and half mile rising east.

The works will be moderate, the cuttings being in gravel with a small proportion of rock. No streams are crossed which require bridging.

After passing the summit the line turns to the west and follows the north bank of Qualcho Lake and the creek of the same name to the 448th mile, where it crosses to the south bank and continues on that side to the 450th mile. Here the formation is 2,768 feet above sea level, showing a descent in 20 miles of 337 feet, nearly all of which is made after passing the western end of Qualcho Lake at the 437th mile, so that there are 5 miles of a gradient of 1 per 100.

The works for about 4 miles on Qualcho Creek will be heavy, and the rest medium with little or no rock. The only stream to be bridged is Qualcho Creek, 50 feet wide at the 448th mile.

From the 450th mile the line bends to the south, passes close to the shore of Tsigutlat Lake at the 454th mile and descending the valley of Iltasyouco River to its junction with the Salmon River, crosses the latter, and rejoins the line last described at the 445th mile on that line and the 463rd on this.

The elevation of this point is 2,465 feet, being a fall of 303 feet in 13 miles, on 3¼ miles of which the gradient is 1 per 100 rising east.

On this section there will be about five miles of heavy work, and on the balance the works will be moderate.

The Iltasyouco is crossed at 454½ miles, and again at the 456½th mile--it is 200 feet wide in each place; the Salmon River is crossed at 461½ miles, in a canyon 150 feet wide with perpendicular walls of rock.

A loop line was explored, diverging from the line just described at the 257th mile, which, after crossing the Chilacoh River, ascends rapidly till the level of the plateau is gained, and then it follows a very direct course to Tsinkut Lake, where it rejoins the line surveyed at the 311th mile, saving about 12 miles in distance.

For the first four miles, till the plateau is reached, the gradients would be steep and the works heavy. Afterwards, the line runs through a flat country with numerous lakes. The gradients on this part would be undulating, and the works light.

Between the 353rd and 371st miles a loop line was surveyed by a parallel valley which would cut off a bend of the Nechacoh and shorten the line five miles. This line, however, would entail a local summit 100 feet higher than the line before described, requiring steeper gradients and about four miles of heavy works. There is also a ravine to be crossed 1,200 feet wide and 100 feet deep.

There was an exploration made for an alternative line, which would turn to the westward of the 419th mile, follow up Tizick Creek to Tizick Lake, and after passing over the summit at an elevation of about 3,050 feet above sea level, would descend by Natouza Lake and a cross valley to Qualcho Creek, where it would rejoin the line before described at the 445th mile. The summit would be about 50 feet lower than that surveyed, and the gradients and works probably easier, but the length about the same.

The two alternative lines first mentioned would, if both were adopted, shorten the distance about 17 miles, making the total length of the line almost the same as that by the Blackwater.

The timber throughout consists of black pine and poplar, with Douglas fir on the ridges, spruce in the swamps, and a few cotton-woods on the banks of the streams.

The Indians have several small gardens on the shores of Noolki and Tachick Lakes and Stoney Creek, in which they grow potatoes, carrots and turnips. They also keep a number of milch cows. This can be done to advantage, as a large proportion of the country between the 311th and 324th miles consists of open prairies with a luxuriant growth of grass of various kinds.

I have the honour to be, Sir,

Your obedient servant,

MARCUS SMITH.

SANDFORD FLEMING, Esq.,
Engineer in Chief,
Canadian Pacific Railway.

APPENDIX U.

CORRESPONDENCE, QUERIES AND NAUTICAL EVIDENCE RESPECTING THE HARBOURS AND WATERS ON THE COAST OF BRITISH COLUMBIA.

The Colonial Secretary to the Governor-General of Canada.

DOWNING STREET, 3rd January, 1877.

MY LORD,---With reference to my despatch, No. 347, of the 30th November, I have the honour to transmit to your Lordship the enclosed copies of letters from the Admiralty, forwarding the answers of various naval officers to certain questions propounded by Mr. Sandford Fleming relating to the selection of a site on the Pacific coast of a terminus for the Canadian Pacific Railway.

These papers will no doubt be communicated to Mr. Fleming, who has recently returned to Canada.

I am, &c.,
(Signed) CARNARVON.

Governor-General,
The Right Honourable
The EARL OF DUFFERIN,
K.P., G.C.M.G., K C.B.

The Admiralty to the Colonial Office.

ADMIRALTY, 27th December, 1876.

SIR,---I am commanded by my Lords Commissioners of the Admiralty to send you herewith, for the information of the Earl of Carnarvon, the answers which have been received from the naval officers named overleaf as to the best site for the terminus of the Canadian Pacific Railway on the Pacific Coast.

I am, &c.,
(Signed) VERNON LUSHINGTON.

The Under-Secretary of State,
Colonial Office.

Vice-Admiral Hon. A. COCHRANE,
Rear Admiral G. H. RICHARDS,
Captain W. GRAHAM,
Lieutenant W. COLLINS.

Admiral Cochrane to the Admiralty.

UNITED SERVICE CLUB,
PALL MALL, S. W., 20th December, 1876.

SIR,---In reply to your letter of the 13th instant, containing directions to forward replies to certain queries by Mr. Sandford Fleming, Chief Engineer of the Canadian Pacific Railway, relative to the question of a site for the terminus of the line on the Pacific Coast, I have the honour to request that you will be pleased to lay before the Lords Commissioners of the Admiralty my replies forwarded herewith to the questions asked.

I have the honour to be, Sir,
Your obedient servant,
ARTHUR A. COCHRANE,
Vice-Admiral.

To Rear Admiral ROBERT HALL, C.B.,
&c., &c., &c.,
Secretary of the Admiralty.

Admiral Richards to the Admiralty.

24 WARINGTON CRESCENT,
20th December, 1876.

SIR,—I have the honour to acknowledge your letter of the 13th inst., requesting that I will reply to certain queries by the Chief Engineer of the Canadian Pacific Railway.

I beg to return the paper containing these queries with such replies as the means at my disposal have enabled me to offer.

I am Sir,
Your very obedient servant,
GEO. HENRY RICHARDS,
Retired Rear Admiral.

The Secretary of the Admiralty,
London.

Captain Graham to the Admiralty.

H.M.S. "BRITANNIA,"
DARTMOUTH, 17th December, 1877.

SIR,—I have the honour to transmit herewith the pamphlet containing Mr. S. Fleming's observations and queries; together with answers thereto, founded on the best of my knowledge.

I have the honour to be, Sir,
Your obedient servant,.
W. GRAHAM,
Captain.

The Secretary of the Admiralty,
London.

Lieutenant Collins to the Admiralty.

H.M.S. "Crocodile,"
Portsmouth, 18th December, 1876.

Sir,—In reply to the Commander-in-Chief's memorandum of the 14th instant, on Admiralty letter,

I have the honour to state that although I was some time serving in the waters of British Columbia, and was to a certain extent mixed up with the Canadian Pacific Railway, I am unable of my own knowledge to give such replies to the queries as would be useful to Mr. Fleming, and satisfactory to myself; but should I be furnished with all the plans and charts, I would then be able to answer such questions as refer to distances, and would do so to the best of my ability.

I have the honour to be, Sir,
Your obedient servant,
W. COLLINS,
Senior Lieutenant.

Admiral George Elliot,
Commander-in-Chief.

Admiral Farquhar to the Admiralty.

Carlogie, Kincardine O'Neil,
20th December, 1876.

Sir,—In compliance with their Lordships' directions, contained in your letter marked M, and dated the 13th instant, I now return the paper emanating from the Colonial Office, with such answers to Mr. Sandford Fleming's queries as I am able to give, only regretting that the answers are so indefinite.

I have the honour to be, Sir,
Your very obedient servant,
A. FARQUHAR,
Vice-Admiral.

The Secretary of the Admiralty,
Whitehall.

The Admiralty to the Colonial Office.

Admiralty, 26th December, 1876.

Sir,—I am commanded by my Lords Commissioners of the Admiralty to send you herewith for the information of the Earl of Carnarvon, a letter from Vice-Admiral A. Farquhar, with such answers to Mr. Sandford Fleming's queries as he is able to give relative to the site for the terminus of the Canadian Pacific Railway on the Pacific coast.

I am, etc.,
(Signed) VERNON LUSHINGTON.

The Under-Secretary of State
for the Colonies.

The Colonial Secretary to the Governor General.

Downing Street, 6th January, 1877.

My Lord,—With reference to my despatch, No. 4, of the 3rd instant, I have the honour to transmit to you a copy of a further letter from the Admiralty forwarding answers from Commander Pender to Mr. Sandford Fleming's questions relating to the site for the terminus on the Pacific coast of the Canadian Pacific Railway.

I have, etc.,
(Signed) CARNARVON.

Governor General
The Right Honourable
The Earl of Dufferin,
K.P., G.C.M.G., K.C.B.

The Admiralty to the Colonial Office.

Admiralty, 4th January, 1877.

Sir,—I am commanded by my Lords Commissioners of the Admiralty, to send you herewith, for the information of the Earl of Carnarvon, the report of Staff-Commander Pender, the chief naval assistant in the Hydrographical Department, as to the best site for the terminus of the Canadian Pacific Railway on the Pacific coast.

Staff-Commander Pender, from his experience as a surveying officer in British Columbia for many years, is well qualified to give an opinion upon the several points specified in the printed memorandum of Mr. Fleming's inquiries.

I am to add that the Colonial Office has now been supplied with all the answers and reports culled by this Department from the naval officers who, in their Lordships' opinion, were most likely to be able to give useful information on the subject.

I am, &c.,
(Signed,) ROBERT HALL.

The Under-Secretary of State,
Colonial Office.

The Colonial Secretary to the Governor General.

Downing Street, 7th April, 1877.

My Lord,—With reference to your telegram of the 13th March, and to my reply of the 17th March, I have the honour to transmit to you herewith, for communication to your Government, the replies which have been received through the Board of Admiralty from Captain Cator, R.N., of Her Majesty's ship "Defence," (late of Her Majesty's ship "Scout,") to Mr. Sandford Fleming's queries as to the site for the terminus of the Canadian Pacific Railway on the Pacific coast.

I have, &c.,
(Signed,) CARNARVON.

Governor General,
The Right Honourable
The Earl of Dufferin,
K.P., G.C.M.G., K.C.B.

The Engineer in Chief to the Finance Minister of Canada.

London, 6th November, 1876.

My Dear Sir,—

* * * * *

There is one branch of the subject respecting which I had hoped to gain valuable information while in England. The officers of Her Majesty's Navy on the Pacific coast, have, for many years, had opportunities of acquiring important knowledge of the several harbours where the land lines are projected to terminate, the approaches thereto from seaward, as well as the anchorage for vessels at different points along the coast.

I have not been able, so far, to obtain the desired information, but it is manifestly so important that every effort should be made to procure it. It is clear that no line through the mountains, however satisfactory in every other respect, could be viewed with favour, unless it led to an eligible harbour and terminal point on the coast.

The Admiralty must be in possession of full information on this head; and I would suggest that application be made, in the proper quarter, in the name of the Canadian Government, for all reports, plans, charts and other documents which may exist.

The information is of very great importance, if not indispensable, to enable the Government properly to arrive at a decision with regard to the terminus and the line which the railway should follow.

The several points on the coast of the mainland, where land lines, which we have under examination, terminate, are as follows:—

1. Burrard Inlet.
2. Howe Sound.
3. Bute Inlet.
4. Bentinck Arm (North).
5. Dean Inlet.
6. Kitlope, Gardner Inlet.
7. Kemano, Gardner Inlet.
8. River Skeena.

The application should, however, not be confined to information respecting these points; it should embrace all that is known with regard to the various inlets and waters of the Pacific coast within the limits of British Columbia.

I am, my dear Sir,

Yours faithfullly,

SANDFORD FLEMING.

The Honorable
R. W. Cartwright,
Finance Minister of Canada,

The Engineer in Chief to the Under Secretary.

27 Belsize Park Gardens, N.W.,
London, 29th November, 1876.

Sir,—The Hon. Mr. Cartwright, Finance Minister of Canada, requested me to examine the charts of the coast of British Columbia, which you obtained from the Admiralty a few days ago; and, in case it should appear that sufficient information was not furnished, with a view to the selection of a terminus for the Canadian Pacific Railway, I was further requested to apply to you, in the hope that you might be able to obtain it.

The charts placed in my hands do not furnish all the information required. I called at your office yesterday to explain what was wanted. I had not the good fortune to see yourself personally, but the gentleman to whom I was referred concurred in the suggestion that I should draw up a series of questions, to be submitted to all the officers, within reach, who have been in command of Her Majesty's ships of war on the North Pacific Station, and who have had opportunities of acquiring information and forming opinions on the subject.

I have now prepared a series of twenty-eight questions, with some preliminary remarks, explanatory of their object. They are framed with a view of eliciting all the information which the Government of Canada require to enable them to come to a speedy determination on this important subject. I respectfully submit them for your consideration.

I am, Sir,
Your obedient servant,
SANDFORD FLEMING,
Engineer in Chief, Canadian Pacific Railway.

R. G. W. Herbert,
Under-Secretary of State for the Colonies,

Observations and queries by Mr. Sandford Fleming, Chief Engineer of the Canadian Pacific Railway, relating to the question of a site for the Terminus on the line of the Pacific Coast. Submitted through the Colonial Office to the Admiralty, London, December, 1876 :—

The Government of Canada has undertaken to establish a line of railway from the Atlantic side of North America to the coast of British Columbia, and has, during the past five or six years, made extensive explorations across the continent, with the view of reaching the Pacific Coast by a practicable and favourable line.

Several routes, more or less practicable, have been discovered, and it is now important to obtain full information respecting the harbours, anchorages and approaches from the ocean, in order to select the most eligible terminal point for the railway on the Pacific Coast.

The railway lines which have been projected across the Rocky Mountain zone, touch the navigable waters of the Pacific at the following inlets :—

1. Burrard Inlet.
2. Howe Sound.
3. Bute Inlet.
4. Bentinck Arm, North.
5. Dean Inlet.
6. Gardner Inlet.
7. Skeena River.

In order that information may be elicited from competent authorities to guide in selecting a suitable terminal point for the railway, it is considered advisable to solicit written replies to a series of questions herewith presented.

It may be stated that while the immediate object of the proposed undertaking is to connect the Pacific Coast with the existing Canadian railway system on the Atlantic seaboard by a line wholly within British territory, it is of primary imporance to select such a route and western terminus as will best command traffic, in order that the railway may ultimately become self-sustaining, or as little burdensome as possible.

No local traffic now exists in any portion of the vast territory to be traversed by the railway commensurate with the cost of the undertaking; it is the more important, therefore, to give due consideration to "through trade," and in establishing the railway, to select such a route and terminus as will afford the greatest possible facilities for successfully competing with foreign routes for ocean-borne traffic.

The coast of the mainland of British Columbia extends from the 49th parallel of latitude to the 55th. Within these limits the seven inlets above mentioned are situated. This extensive coast may be reached from the open ocean by three main passages or channels, as follows: —

1st. A southern channel, extending between the coast of the United States and the southerly coast of Vancouver Island.

2nd. A northern channel, extending between the Queen Charlotte Islands and Alaska.

3rd. A middle channel, extending between Vancouver Island and the Queen Charlotte Islands.

Ocean-borne traffic may reach the coast of the mainland of British Columbia through either of these channels, and the first consideration which presents itself is with respect to the one whose geographical situation is most favourable for that description of trade.

Information on this head may be furnished in connection with questions Nos. 1, 2 and 3.

It will be observed in the questions which follow, that attention is drawn to some details in connection with the more northerly inlets. This is due to the incomplete character of the charts of the coast north of Vancouver Island.

Questions.

Question 1.—What is the distance from a common point on the Asiatic coast, say, Yokohama, to the centre of the Southern Channel, on a line drawn from Cape Flattery to Point Bonilla?

Question 2.—What is the distance from Yokohama to the centre of the Middle Channel on a line drawn from Cape Scott to Cape St. James?

Question 3.—What is the distance from Yokohama to the centre of the Northern Channel, on a line drawn from Cape Knox to Cape Muzon ?

Question 4.—What is the distance from the centre of the Southern Channel, (point defined in question No. 1) to the head of Burrard Inlet; and also to English Bay ? How much of these distances would ocean-going ships require to be towed ?

Question 5.—What is the distance from (point defined in No. 1) Southern Channel to the head of Howe Sound ? How much of this distance would sailing ships, under ordinary circumstances, require to be towed ?

Question 6.—What is the distance from Southern Channel (point defined in No. 1), to Waddington Harbour, Bute Inlet ? How much of this distance would sailing ships require to be towed ?

Question 7.—Would the course of vessels to Burrard Inlet, Howe Sound or Bute Inlet, as alluded to in Questions Nos. 4, 5 and 6, in the event of hostilities with the United States, be exposed so as to render the approach to the terminus difficult or hazardous ?

Question 8.—At what minimum distance would vessels have to pass San Juan Island or other islands or coasts of the United States, in their passage by the Southern Channel to Burrard Inlet, Howe Sound or Waddington Harbour.

Question 9.—Could large sea-going ships, approaching by the Middle Channel, pass without danger or difficulty through by Johnston's Strait to Burrard Inlet, Howe Sound, or Waddington Harbour?

Question 10.—What is the distance from the Middle Channel (point defined in Question 2) to Burrard Inlet? How much of this distance would sailing ships have to be towed ?

Question 11.—What is the distance from the Middle Channel, (point defined No. 2) to Howe Sound ? How much of this distance would sailing ships require to be towed ?

Question 12.—What is the distance from the Middle Channel (point defined No. 2) to Waddington Harbour? How much of this distance would sailing ships require to be towed ?

Question 13.—What is the distance from the Middle Channel (point defined in Question 2) to the head of North Bentinck Arm, *viâ* Fitzhugh Sound? How much of this distance would sailing ships, under ordinary circumstances, require to be towed ?

Question 14.—What is the distance from the Middle Channel (point defined No. 2) to North Bentinck Arm, *viâ* Milbank Sound ? How much of this distance would sailing ships require to be towed ?

Question 15.—What is the distance from the Middle Channel (point defined Question 2) *viâ* Milbank Sound, to the anchorage near the head of Dean Channel, and how much of this distance would sailing ships require to be towed ?

Question 16.—On the coast north-westerly from Milbank Sound the chart indicates anchorages at Morris Bay, Cockle Bay, and at Port Blakeney. Also, on the course to Dean Channel and North Bentinck Arm, at Hampden Bay, and at Port John. Are you aware of other anchorages in these waters ?

Question 17.—What is the distance from the Middle Channel (point defined in Question 2) to the anchorage opposite Triumph Bay, Garden Inlet, *viâ* Milbank Sound and Finlayson Channel ? How much of this distance would sailing ships require to be towed ?

Question 18.—Besides the anchorages at Milbank Sound, mentioned in Question 16, the chart indicates, on the course referred to in Question 17, anchorages at Nowish Cove, Klemtoo Passage, Carter Bay, Swanson Bay, Khutze, Aaltanhash, Klekane, Fisherman's Cove and Bishop's Cove. Are you aware of other anchorages in these waters ?

Question 19.—What is the distance from the Northern Channel (point defined in Question No. 3) to the anchorage at Triumph Bay, Gardner Inlet, *viâ* Principe Channel, Cridge and Verney Passages? How much of this distance would it be necessary to tow sailing ships ?

Question 20.—By the route described in the last quesiton, the chart indicates anchorages at Port Canaveral, Port Stephens, and at Coghlan ; are you aware of other anchorages in these passages ?

Question 21.—What is the distance from the Northern Channel (point defined in Question No. 3) to Triumph Bay anchorage, Gardner Inlet, *viâ* Brown Passage and Grenville Channel ? How much of this distance would sailing ships require to be towed ?

Question 22.—Along the route described in last question, the chart indicates inside of Brown Passage, anchorages at Qlawdzeet, Refuge Bay, Cardena Bay, Stewart Anchorage, Klewnuggit Inlet, Lowe Inlet and Coghlan Anchorage. Are you aware of other anchorages in these waters ?

Question 23.—What is the distance between the anchorage opposite Triumph Bay and the anchorage at Kemano, Gardner Inlet ?

Question 24.—What is the distance from the Northern Channel (point defined in Question 3) to Port Essington, near the entrance to River Skeena *viâ* Brown Passage ? How much of this distance would sailing ships require to be towed ?

Question 25.—Are you aware of other anchorages than those already mentioned, inside of Brown Passage and that in North Skeena Passage ?

Question 26.—Generally, are there any objections of a climatic nature to any of the seven inlets herein specially alluded to, such as obstruction from ice ? If so, to what extent do they exist in each case?

Question 27.—Mention any special advantages or disadvantages appertaining to any of the seven inlets herein alluded to, which have not been touched upon in the foregoing questions, and your replies thereto.

Question 28.—Having regard to naval and commercial considerations, mention the point on the coast which appears to you the most suitable for the railway terminus, and designate the other points to which reference has herein been made, in the order of preference.

The Admiralty has furnished, through the Colonial office, the replies which follow from the undermentioned naval officers:—

Vice-Admiral Hon. A. A. Cochrane.
Rear-Admiral C. H. Richards.
Vice-Admiral A. Farquhar.
Captain R. P. Cator.
Captain W. Graham.
Staff Commander D. Pender.
Lieutenant W. Collins.

Question 1. What is the distance from, a common point on the Asiatic coast, say, Yokohama, to the centre of the southern channel, on a line drawn from Cape Flattery to Point Bonilla?

Replies—Admiral Cochrane.. 4,300 miles
Admiral Richards.. 4,115 "
Admiral Farquhar .... "
Captain Graham.. 4,103 "
Captain Cator.. 4,300 "
Commander Pender.. 4,300 "
Lieutenant Collins.. ...... "

Question 2. What is the distance from Yokohama to the centre of the Middle Channel on a line drawn from Cape Scott to Cape St. James?

Replies—Admiral Cochrane.. 4,000 miles
Admiral Richards.. 3,870 "
Admiral Farquhar .... "
Captain Graham.. 3,855 "
Captain Cator.. 4,052 "
Commander Pender.. 4,000 "
Lieutenant Collins.. ...... "

Question 3. What is the distance from Yokohama to the centre of the Northern Channel, on a line drawn from Cape Knox to Cape Muzon?

Replies—Admiral Cochrane.. 3,820 miles
Admiral Richards.. 3,694 "
Admiral Farquhar.. ...... "
Captain Graham .... 3,678 "
Captain Cator.. 3,893 "
Commander Pender .... 3,820 "
Lieutenant Collins. .... "

Question 4.—What is the distance from the centre of the southern channel, (point defined in question No. 1.) to the head of Burrard Inlet; and also to English Bay? How much of these distances would ocean-going sailing ships require to be towed?

Replies—Admiral Cochrane.—140 and 120 miles respectively.

Admiral Richards.—165 to head of Inlet. Towage, 90 miles.
" 145 to English Bay. Towage 70 miles.
All things being equal, English Bay is the natural terminus on the Pacific shore; much, indeed, might be profitably sacrificed on the land route to secure this good anchorage, convenient in all respects.

Admiral Farquhar.—Distances not accurately known, but ocean-going sailing ships could not be depended on to *sail* further than the entrance of Haro Channel, although, doubtless, with fair winds and favourable weather, they might sail to English Harbour, at the entrance of Burrard Inlet.

Captain Graham.—165 and 140 miles.

Captain Cator.—About 142 miles to Port Moody, and 130 miles to English Bay. To be towed through Haro Straits (50 miles) and from English Bay to Port Moody (12 miles).—N.B. Sailing ships frequently make this passage under sail to English Bay and also to Port Nanaimo and Departure Bay. Nearly two-thirds of the sailing ships use the Rosario Straits (American Territory) and some the Haro Straits.

Commander Pender.—142 and 122 miles respectively. Towage from Race Rocks, or 90 and 70 miles respectively.

Lieutenant Collins.—

Question 5.—What is the distance from (point defined in No. 1) southern channel, to the head of Howe Sound How much of this distance would sailing ships, under ordinary circumstances, require to be towed?

Replies—Admiral Cochrane.—145 miles.

Admiral Richards.—165 miles. Towage 90 miles.

Admiral Farquhar.—Distances not accurately known, but the same answer as given to 4, as regards ships being towed, applies to Howe Sound.

Captain Graham.—215 miles. Towage 30 miles.

Captain Cator.—About 150 miles. To be towed through Haro. The whole distance can be under sail.

Commander Pender.—145 miles. Towage about 95 miles, or from Race Rocks.

Lieutenant Collins.—

Question 6.—What is the distance from southern channel (point defined in No. 1), to Waddington Harbour, Bute Inlet? How much of this distance would sailing ships require to be towed?

Replies—Admiral Cochrane.—245 miles.

Admiral Richards.—270 miles. Towage 195 miles.

ADMIRAL FARQUHAR.—Distance not accurately known, but same answers as given to Nos. 4 and 5, apply to Bute Inlet.

CAPTAIN GRAHAM.—300 miles. Towage 40 miles.

CAPTAIN CATOR.—About 260 miles. To be towed through Haro Straits (50 miles) and from Sutil Channel (off St. Mary's Island) to Waddington Harbour (50 miles). The whole distance can be done under sail.

COMMANDER PENDER.—245 miles. Towage about 195 miles, or from Race Rocks.

Note.—The distances from Nos. 4, 5 and 6 are through Active Pass. If the passage between Saturna and Patos Islands were used, the distances would, in each case, be 10 miles longer.

LIEUTENANT COLLINS.—

Question 7.—Would the course of vessels to Burrard Inlet, Howe Sound or Bute Inlet, as alluded to in Questions Nos. 4, 5 and 6, in the event of hostilities with the United States, be exposed so as to render the approach to the terminus difficult or hazardous?

Replies.—ADMIRAL COCHRANE.—If the Americans had command of the sea, the approach of vessels to the terminus on the courses named would be hazardous.

ADMIRAL RICHARDS.—Yes, if the United States had a superior naval force.

ADMIRAL FARQUHAR.—Yes, unless an inner channel, out of reach of guns placed on the Island of San Juan, is found navigable.

CAPTAIN GRAHAM.—Whether difficult or hazardous would depend upon the naval force of the United States in the locality.

CAPTAIN CATOR.—Yes; certainly, as they have to pass through Haro Straits, where they would be within range both day and night, into the Straits of Georgia.

COMMANDER PENDER.—Juan de Fuca Strait, under these conditions, would be somewhat similar to the British Channel. The strait is eight miles across at its narrowest part, between Race Rocks and Point Angelos, and ten miles wide at the western entrance. On the Vancouver or British shore, ships of war engaged in protecting commerce could find at Barclay Sound, Port San Juan, Beecher Bay, Peddar Bay, Royal Road, Esquimalt and Victoria Harbours, and in the Haro Strait in Cormorant Bay. On the American shore, Neeah Bay, five miles within Cape Flattery and Port Angelos, opposite Race Rocks, would correspond with Port San Juan and Beecher Bay on the Vancouver shore.

LIEUTENANT COLLINS.—

Question 8.—At what minimum distance would vessels have to pass San Juan Island or other islands or coasts of the United States, in their passage by the southern channel to Burrard Inlet, Howe Sound or Waddington Harbour?

Replies.—ADMIRAL COCHRANE.—About five miles.

ADMIRAL RICHARDS.—Ships need not pass as far off as within three miles of San Juan, but they must pass within two miles of Stuart and Cato Islands, unless indeed they take the inner channel along the coast of Vancouver Island; and the passages from these channels into the Strait of Georgia are dangerous, and they would not be used unless in case of emergency.

ADMIRAL FARQUHAR.—Distances not accurately known, but the bluff on the north end of San Juan, armed with heavy guns, would command the passage. Rosario channel is wider, but both sides belong to the United States.

CAPTAIN GRAHAM.—Four and a-half sea miles from San Juan.

CAPTAIN CATOR.—About $2\frac{1}{2}$ miles from San Juan, as far as I can recollect, and close to Stewart and Waldron Islands, the two last, I believe, belong to the United States. The anchorages at Waldron Island are frequently used by sailing vessels passing to and from Haro Straits.

COMMANDER PENDER.—Not necessarily within five nautical miles (of 6,080 feet); Zero Rock in Haro Strait being that distance from the nearest part of San Juan Island, and there is even a passage westward of the rock (Zero) or between it and Vancouver Island shore.

LIEUTENANT COLLINS.—

Question 9.—Could large sea-going ships, approaching by the middle channel, pass without danger or difficulty through by Johnston's Strait to Burrard Inlet, Howe Sound, or Waddington Harbour.

Replies.—ADMIRAL COCHRANE.—No.

ADMIRAL RICHARDS.—The approach would always be attended with some danger, especially during the frequent fogs.

ADMIRAL FARQUHAR.—As I have not passed through Johnston's Strait, I cannot, from personal experience, speak as to its facilities for navigation, but I have understood from officers under my orders that the navigation is intricate and difficult for large vessels (even steamers), and impracticable for ocean sailing vessels.

CAPTAIN GRAHAM.—Yes.

CAPTAIN CATOR.—Vessels could pass with a commanding breeze from the westward, but other than that, the approach to Johnston's Straits would be exceedingly hazardous. Vessels going through Johnston's Straits and Discovery Passage, would have to pass Seymour Narrows, and I certainly would not recommand their attempting it without steam, as the tides run with great velocity.

When in H.M.S. "Scout," after passing Seymour Narrows and from thence to past Cape Mudge (Valdes Island) under steam with the current, we went over the ground over 20 knots per hour.

The United States steamship of war, "Saranac," 2,000 tons, 576 H. P. nominal, when passing through Queen Charlotte's Sound, became unmanageable in consequence of the strong tide, was swept on shore and totally lost.

Commander Pender.—It would not be impossible, but would be attended with an aggravated amount of risk and delay.

Lieutenant Collins.—

Question 10.—What is the distance from the middle channel (point defined in Question 2) to Burrard Inlet? How much of this distance would sailing ships require to be towed?

Replies.—Admiral Cochrane.—320 miles.

Admiral Richards.—320 miles; towage all the way, generally.

Admiral Farquhar.—I cannot answer this question (No. 10) with any degree of accuracy.

Captain Graham.—280 miles. 130 miles.

Captain Cator.—About 260 miles. To be towed 160 miles, from entrance of Middle Channel to Oyster Bay, south of Discovery Passage; the rest of the distance can be done under sail.

Commander Pender.—320 miles. From Nahwitti Bar, or about 305 miles.

Lieutenant Collins.—

Question 11.—What is the distance from the middle channel (point defined, No. 2) to Howe Sound? How much of this distance would sailing ships require to be towed?

Replies.—Admiral Cochrane.—315 miles.

Admiral Richards.—315 miles. Towage generally all the way.

Admiral Farquhar.—

Captain Graham.—265 miles. 150 miles.

Captain Cator.—About 275 miles. To be towed 160 miles (from entrance of Middle Channel to Oyster Bay, south of Discovery Passage). The rest of the distance can be made under sail.

Commander Pender.—315 miles. About 200 miles, or from Nahwitti Bar.

Lieutenant Collins.—

Question 12.—What is the distance from the middle channel (Point defined No. 2) to Waddington Harbour? How much of this distance would sailing ships require to be towed?

Replies—Admiral Cochrane.—275 miles.

Admiral Richards.—240 miles. Towage all the way, generally.

Admiral Farquhar.—

Captain Graham.—210 miles. 160 miles.

Captain Cator.—About 220 miles. Other conditions as to towing and sailing, the same as No. 11.

Commander Pender.—275 miles. From Nahwitti Bar, or about 260 miles.

Lieutenant Collins.—

Question 13.—What is the distance from the Middle Channel (Point defined in Question 2) to the head of North Bentinck Arm, *viâ* Fitzshugh Sound? How much of this distance would sailing ships, under ordinary circumstances, require to be towed?

Replies.—Admiral Cochrane.—160 miles.

Admiral Richards.—150 miles. All towage.

Admiral Farquhar.—

Captain Graham.—148 miles. 88 miles.

Captain Cator.—About 160 miles. To be towed 100 miles. The whole distance can be done under sail.

Commander Pender.—160 miles. From Safety Cove to head of Arm, or 75 miles.

Lieutenant Collins.—

Question 14.—What is the distance from the Middle Channel (Point defined No. 2) to North Bentinck Arm, *viâ* Milbank Sound? How much of this distance would sailing ships require to be towed?

Replies.—Admiral Cochrane.—155 miles.

Admiral Richards.—140 miles. All towage.

Admiral Farquhar.—

Captain Graham.—145 miles. 90 miles.

Captain Cator.—About 150 miles. To be towed 80 miles. The whole distance can be made under sail.

Commander Pender.—155 miles. From western entrance of Seaforth Channel, or 85 miles.

Lieutenant Collins.—

Question 15.—What is the distance from the Middle Channel (Point defined Question 2) *viâ* Milbank Sound, to the anchorage near the head of Dean Channel, and how much of this distance would sailing ships require to be towed?

Replies.—Admiral Cochrane.—160 miles.

Admiral Richards.—About 130 miles. All towage.

Admiral Farquhar.—

Captain Graham.—140 miles. 60 miles.

Captain Cator.—About 135 miles. To be towed 70 miles. The whole distance can be made under sail.

Commander Pender.—Approximately (Dean Channel not yet surveyed,) 160 miles. From western entrance of Seaforth Channel, or approximating 90 miles.

Lieutenant Collins.—

Question 16.—On the coast north-westerly from Milbank Sound the chart indicates anchorages at Morris Bay, Cockle Bay, and at Port Blakeney. Also, on the course to Dean Channel and North Bentinck Arm, at Hampden Bay, and at Port John. Are you aware of other anchorages in these waters?

Replies.—Admiral Cochrane.—No,

Admiral Richards.—I am not personally acquainted with these anchorages.

Admiral Farquhar.—I am not acquainted with any other anchorages.

Captain Graham.—No; but I have never been in the locality.

Captain Cator.—No.

Commander Pender.—These are the only known anchorages between Seaforth Channel and Finlayson Channel; but Kynumpt Harbour, ten miles within Seaforth Channel, on the south side, is the best harbour in this district north of Safety Cove. Hampden Bay, though a fair anchorage, is situated in Gunboat Passage, and that is not a suitable passage for ocean steamships. The course for large ships, from Milbank Sound to Fisher Channel, is by Seaforth Channel and Lame Passage, through the main pass; here, in addition to Kynumpt Harbour, there is fair anchorage at Klik-tso-atle Harbour, and in McLaughlin Bay. In Fitzhugh Sound, Namee Harbour may be temporarily used, but is subjected to furious whirlwinds in south-east gales. Safety Cove is secure in all weathers; and in Queen Charlotte Sound, Schooner Retreat and Takush Harbour may be used.

Lieutenant Collins.—No; I am not.

Question 17.—What is the distance from middle channel (point defined in question 2) to the anchorage opposite Triumph Bay, Gardner Inlet, *via* Milbank Sound and Finlayson Channel? How much of this distance would sailing ships require to be towed?

Replies.—Admiral Cochrane.—170 miles.

Admiral Richards.—Triumph Bay not shown on any chart I have, but the water route is untenable.

Admiral Farquhar.—

Captain Graham.—165 miles. 64 miles.

Captain Cator.—About 170 miles. To be towed 100 miles. The whole distance can be made under sail.

Commander Pender.—Approximately 170 miles (Gardner Inlet not surveyed). From the northern part of Milbank Sound, or about 95 miles.

Lieutenant Collins.—

Question 18—Besides the anchorages at Milbank Sound, mentioned in question 16, the chart indicates on the course referred to in Question 17; anchorages at Nowish Cove, Klemtoo Passage, Carter Bay, Swanson Bay, Khutze, Aaltanhash, Klekane, Fisherman's Cove and Bishop's Cove. Are you aware of other anchorages in these waters?

Replies.—Admiral Cochrane.—No.

Admmiral Richards.—Not acquainted with these anchorages personally.

Admiral Farquhar.—No other anchorages have been brought under my notice.

Captain Graham.—

Captain Cator.—No.

Commander Pender —Of these anchorages, Klemtoo Passage and Carter Bay are the only ones suitable for large ships. Swanson Bay is merely a stopping place; and the anchorages alluded to between that Bay and Fisherman's Cove are from Indian report, and I have no knowledge of any vessel having anchored in either of these places. Home's Bay, at the north-west part of Princess Royal Island, is fit for a large ship, and is, in fact, the best anchorage between Wright Sound and Finlayson Channel.

Lieutenant Collins.—No; I am not.

Question 19.—What is the distance from the Northern Channel (point defined in Question No. 3) to the anchorage at Triumph Bay, Gardner Inlet, *via* Principe Channel, Cridge and Verney Passages? How much of this distance would it be necessary to tow sailing ships?

Replies.—Admiral Cochrane.—190 miles.

Admiral Richards—Same as reply No. 17.

Admiral Farquhar.—

Captain Graham—250 miles, 90 miles.

Captain Cator.—About 200 miles. To be towed 100 miles. The whole distance can be made under sail.

Commander Pender.—190 miles. About 90 miles, or from the northern entrance to Principe Channel.

Lieutenant Collins.—

Question 20.—By the route described in the last question, the chart indicates anchorages at Port Canaveral, Port Stephens, and at Coghlan; are you aware of any other anchorages in these passages?

Replies.—Admiral Cochrane.—No.

Admiral Richards.—Not acquainted with these anchorages personally.

Admiral Farquhar.—No other anchorages have been brought under my notice.

Captain Graham.—

Captain Cator.—No.

Commander Pender.—As far as I know there are no other anchorages; and Coghlan anchorage is the only one which would be of service to large ships, and which may be considered of great value here.

Lieutenant Collins.—No; I am not.

Question 21.—What is the distance from the northern channel (point defined in Question No. 3) to Triumph Bay anchorage, Gardner Inlet, *viâ* Brown Passage and Grenville Channel. How much of this distance would sailing ships require to be towed?

Replies.—Admiral Cochrane.—185 miles.

Admiral Richards.—Same reply as No. 17.

Admiral Farquhar.—

Captain Graham.—220 miles. 100 miles.

Captain Cator.—About 200 miles. To be towed 130 miles. The whole distance can be made under sail.

COMMANDER PENDER.—Approximately, 185 miles. From Brown Passage or about 115 miles.

LIEUTENANT COLLINS.—

Question 22.—Along the route described in last question, the chart indicates inside of Brown Passage, anchorages at Qlawdzeet, Refuge Bay, Cardena Bay, Stewart Anchorage, Klewnuggit Inlet, Lowe Inlet and Coghlan Anchorage. Are you aware of other anchorages in these waters ?

Replies.—ADMIRAL COCHRANE.—No.

ADMIRAL RICHARDS.—Same as reply No. 20.

ADMIRAL FARQUHAR.—No other anchorages have been brought under my notice.

CAPTAIN GRAHAM.—No ; but have not visited the locality.

CAPTAIN CATOR.—Yes ; Duncan Bay. Metlah Catlah Bay and North Skeena Pass.

COMMANDER PENDER.—There is also anchorage north of Mount McGrath, in Chismore Passage, Chalmer's anchorage, and Alpha Bay, in the east part of Chatham Sound, Metlah Catlah Harbour, Duncan Bay, Big Bay, and lastly, Fort Simpson, at the north part of Tsimpsean Peninsula, is the finest harbour north of Beaver Harbour, in Vancouver Island.

LIEUTENANT COLLINS.—No; I do not.

Question 23.—What is the distance between the anchorage opposite Triumph Bay and the anchorage at Kemano, Gardner Inlet.

Replies.—ADMIRAL COCHRANE.—20 miles.

ADMIRAL RICHARDS.—

ADMIRAL FARQUHAR.—

CAPTAIN GRAHAM.—20 miles.

CAPTAIN CATOR.—About 22 miles.

COMMANDER PENDER.—Approximately, 20 miles (unsurveyed).

LIEUTENANT COLLINS.—

Question 24.—What is the distance from the northern channel (point defined in Question 3) to Port Essington, near the entrance to River Skeena *viâ* Brown Passage. How much of this distance would sailing ships require to be towed ?

Replies.—ADMIRAL COCHRANE.—113 miles.

ADMIRAL RICHARDS.—120 miles, half of it towage.

ADMIRAL FARQUHAR.—

CAPTAIN GRAHAM.—116 miles.

CAPTAIN CATOR.—About 120 miles. To be towed 30 miles. The whole distance can be made under sail.

COMMANDER PENDER.—About 98 miles to the only known anchorage (north of Mount McGrath, and about 113 miles to what is called Port Essington.) This portion of the Skeena River is unsurveyed. —About 43 miles, or from Brown Passage to Port Essington. *Note* The distance by Telegraph Passage, would be about 130 miles, but

that part has not been surveyed, and I only know of a small river steamboat having ascended the Skeena River through that passage.

LIEUTENANT COLLINS.—

Question 25.—Are you aware of other anchorages than those already mentioned, inside of Brown Passage and that in North Skeena Passage?

Replies.—ADMIRAL COCHRANE.—No; except Metlah Catlah Harbour.

ADMIRAL RICHARDS.—

ADMIRAL FARQUHAR.—No other anchorages have been brought under my notice.

CAPTAIN GRAHAM.—No.

CAPTAIN CATOR.—Yes; Duncan Bay and Metlah Catlah Bay.

COMMANDER PENDER.—There is also anchorage north of Mount McGrath in Chismore Passage, Chalmers Anchorage, and Alpha Bay, in the east part of Chatham Sound:—Metlah Catlah Harbour, Duncan Bay, Big Bay, and lastly, Fort Simpson at the north part of Tsimpsean Peninsula, is the finest harbour north of Beaver Harbour in Vancouver Island.

LIEUTENANT COLLINS.—Never been there.

Question 26.—Generally, are there any objections of a climatic nature to any of the seven inlets herein specially alluded to, such as obstructions from ice? If so, to what extent do they exist in each case?

Replies.—ADMIRAL COCHRANE.—It is to be apprehended that the navigation of all the Inlets referred to would be much interfered with in the winter time by ice, with the exception of Burrard Inlet or Harbour. Dense fogs in summer and snow storms in winter, together with the general absence of anchoring ground, owing to the great depth of water in, and the precipitous sides of, the fiords or inlets, render navigation in them, if to be conducted at any speed, almost impossible. In the spring of the year, the rivers at the head of the inlets, and the mountain torrents which descend from the glaciers, carry into the inlets large quantities of trees, and these floating for a long period would render navigation at night time hazardous. At a distance of 20 and 30 miles from the head of the fiords, I found the water at the surface and to a considerable depth to be quite fresh; this would much facilitate the formation of ice.

ADMIRAL RICHARDS.—The further north the greater are the objections, on account of climate, boisterous weather, fogs, ice, &c.

ADMIRAL FARQUHAR.—As far as my experience goes, there are no decided objections of a climatic nature to Burrard Inlet, Howe Sound, or Bute Inlet. Undoubtedly further north the climate becomes more severe, and navigation might be impeded by ice in the inlets.

CAPTAIN GRAHAM.—

CAPTAIN CATOR.—I have never visited any of the seven Inlets during the winter months, but from what came under my personal observation in H.M.S. "Scout," December 25th, 1871, ship frozen in, in Garden Bay, Pender Harbour, Seechelt Peninsula, and 28th December, 1872, while at anchor at Esquimault, the harbour was frozen over, ice $\frac{1}{8}$ inch thick, as also the reports in local newspapers at Victoria, Vancouver, of the severity of the winter, in the years 1871 and

1872, in the north, and of the River Skeena being frozen up, the thermometer 30 degrees below zéro, I should conclude that all Inlets north of 1, 2 and 3 would certainly be subject to obstructions from ice, and to a great extent.

It would be most hazardous for a sailing ship to attempt the entrance of any of the Inlets 4, 5, 6 and 7, even if obstructions from ice did not exist, as very bad weather is experienced in the North and Middle Channels during the winter months. Strong gales are very frequently accompanied with frost, snow, hail, rain and thick weather, and a very nasty sea runs between Cape St. James and Cape Scott. being open from E. by S. to N. W. by N.

H.M.S. "Peterel," in March 1873, was nearly wrecked in a snow storm off the Southern entrance of Fitzhugh Sound, when sent to render assistance to the crew of an American steam Transport which was totally lost with all hands, between the entrance of Fitzhugh and Queen Charlotte Sound.

Commander Pender.—These Inlets proper are mostly of the same character; the shores rise abruptly to a considerable height and the water is too deep, as a rule, for an anchor to be dropped. Generally they are fresh on the surface a considerable distance from the land, and in some winters there is much floating ice, but I am not aware of any obstruction to navigation on that account. Fogs, gales of wind, with thick weather, strong tides, and close and intricate navigation are more the sources of danger to large ships. Again, during dry summers, sometimes for two or three months together, the entire country is enveloped in smoke, (originating in Indian bush fires), making it difficult to see the shores even in the narrowest parts, and increasing the risks of navigating the inner channels to a dangerous extent.

Lieutenant Collins.—Climate all that can be desired.

Question 27.—Mention any special advantages or disadvantages appertaining to any of the seven inlets herein alluded to, which have not been touched upon in the foregoing questions and your replies thereto?

Admiral Cochrane.—I consider that no ocean terminus of the trans-Atlantic Railway should be situated at the head or in any part of the fiords or inlets enumerated in the preamble to the questions forwarded. This view would limit the number of sites suggested for the terminus to three, viz: Burrard Inlet, Skeena River or Metlah Catlah, and some part in "Milford Haven." Of these I select Burrard Inlet as offering the greatest advantages.

I would suggest that with a view to insure a considerable amount of freedom of navigation in the Straits of San Juan de Fuca, in case of war with the United States, that arrangements should be made with the United States Government of a similar character to those which I believe exist with advantage on the Canadian lakes, and calculated to ensure neutrality in the close waters adjacent to British and American shores in the Straits of San Juan. I beg to submit that applications should be made to the United States to cede to Canada the point of land "Cape Robert," to the south of the Fraser River. This piece of American territory is about 20 miles in area; is isolated from American soil, being a point of land projecting into the sea from Canadian territory, but south of the 49th parallel. In case of the terminus being made at Burrard Inlet, this piece of land might be a fruitful source

of annoyance. It is at present almost uninhabited, but the land is level and well wooded.

ADMIRAL RICHARDS.—

ADMIRAL FARQUHAR—I can speak with more certainty of the value of Burrard Inlet as a terminus than of any of the others. Burrard Inlet has the advantage of being the southernmost, at no great distance from a wide channel; has a deep, clear entrance; possesses a splendid harbour (Right Arm), and a fair anchorage outside (English Bay), and is almost immediately opposite Nanaimo, the great coal depôt. Howe Sound does not appear to me to have equal advantages. Bute Inlet I consider more difficult of access than either of the other two, but if it were practicable to bridge Seymour Narrows, the railway might be continued to a point on the south or west coast of Vancouver.

CAPTAIN GRAHAM.—

CAPTAIN CATOR.—Of the seven Inlets alluded to, I should select Waddington Harbour (Bute Inlet) for a terminus for the Canadian Pacific Railway, as being the most central, and opposite to Port Augusta, which strikes the very centre of Vancouver Island.

Nos. 1 and 2 are too near the United States Territory, in case of hostilities with that country. Nos. 4, 5, 6 and 7 too far north, where very bad weather is experienced during the winter months.

COMMANDER PENDER—Dean Inlet, Gardner Inlet, and Skeena River entrances are unsurveyed, so I cannot speak from any personal knowledge. Of the remaining inlets, Burrard Inlet, though without anchorage at its head, yet with the anchorages at English Bay, at Coal Harbour, at Port Moody, and in Bedwell Bay, it is manifestly of the greatest value. Howe Sound affords no anchorage at its head. At Bute Inlet, Waddington Harbour is but an indifferent anchorage, and Bentinck Arm is even more limited and objectionable as an anchorage for large ships.

LIEUTENANT COLLINS—My knowledge of these seven inlets is very limited.

Question 28.—Having regard to naval and commercial considerations, mention the point on the coast which appears to you the most suitable for the railway terminus, and designate the other points to which reference has herein been made, in the order of preference.

Replies.— ADMIRAL COCHRANE.—I am of belief that the most advantageous site for the terminus is, as before stated, that of Burrard Inlet, and that this site will, for many years, hold its supremacy over all others. When population has notably increased on the mainland and on Vancouver, and Queen Charlotte Islands are settled, then the terminus will probably be transferred farther and farther to the northward, until, in my belief, it will eventually reach Berling Straits.

I would mention that in my visit to Queen Charlotte Islands and to Port Simpson, on the borders of Alaska, I caused the temperature of the sea to be constantly observed, and little or no difference was found in the temperature of the sea at that latitude and at Vancouver. The climate of Queen Charlotte Islands, thus tempered by ocean currents, is mild, and their resources from agriculture, mining and fisheries will, at no distant date, be an element of wealth to the Canadian Government.

On my visit to the Port of Metlah Catlah, adjacent to Alaska, I found a large and flourishing settlement of Indians, under charge of Mr. Duncan. The soil was fertile and productive : the fisheries were highly remunerative, and the general and prospective prosperity of the colony all that could be expected.

I mention these facts with a view to show that the climate is not hostile to eventual emigration to the northward.

With reference to questions as to the distance that sailing vessels would require to be towed when making for any of the sites suggested as a terminus for the railway, I would remark that it would be of advantage for all sailing vessels, making for any harbour approached through the Straits of San Juan de Fuca, to be taken in tow to their destination from the time of entering the Straits; and when making for any other anchorage, situated up any of the fiords or inlets, they should be taken in tow when they approach the entrance of such inlets.

Admiral Richards.—From a nautical point of view, Burrard Inlet is every way preferable. I should say English Bay, but if any considerable expense would be saved in the construction of the railway, Port Moody might be adopted. Next in order, from the same point of view, is Howe Sound, then, Bute Inlet. On nautical considerations, all the rest have great disadvantages. Of course the facility for making the railway is paramount to all other considerations. A practicable route, with an inferior water terminus, might be preferable to an almost impracticable route attended with enormous expense and a good terminus, such as Burrard Inlet.

In regard to the three entrances, Fuca Strait immeasurably the best, the middle one out of court entirely, on account of difficulties of navigation. The northern, with Port Essington a terminus preferable to it.

Admiral Farquhar.—I have not sufficient knowledge of the inlets north of Bute Inlet, as to the advantages they possess for the terminus of the Pacific Railway: the open sea may be more easily gained, but the climate must be more rigorous and the approach from sea probably more dangerous. On the whole, if practicable for the railway, I should give the preference to Burrard Inlet. If hostilities at any time broke out between Great Britain and the United States, our first object should be to obtain possession of the island of San Juan, so unfortunately lost to us, it being the key of the channel leading from the Strait of Fuca to the Strait of Georgia.

Captain Graham.—–

Captain Cator.—As the Island of San Juan is now part of the United States Territory, and commanding as it does the Haro Straits by day as well as by night (using the electric light), I should, under these circumstances, select either Uchucklesit or Alberni Harbours in Barclay Sound as the most suitable for a terminus in Vancouver Island, both as regards a Naval Station, as its entrance can so easily be fortified and it quite commands the entrance of the Juan de Fuca Straits; as also for a mercantile emporium, as it is easy of access and departure at all times of the year for sailing ships of any draft of water as, when once clear of Cape Beale you are dead to windward of Cape Flattery some 25 miles, the prevailing winds being from the westward.

The eastern entrance (Barclay Sound) requires a light on Cape Beale (I believe a lighthouse has been erected since my leaving Vancouver in H.M.S. "Scout," 1873) and Deer Island, and one or two small ones further up the entrance, when port would be accessible at all times.

A swell is experienced outside and off Cape Beale, but you soon run into smooth water, and have but to go some 15 miles from the Cape to reach Uchucklesit Harbour.

A steamer would be advantageous at Doger Cove, which is at the entrance of the Middle Channel, available for towing vessels in case of wind failing or calm.

Having selected Waddington Harbour (Bute Inlet) on main land; Uchucklesit or Alberni Harbour (Barclay Sound) Vancouver, for termini, I shall now propose that a small railway be constructed to branch off from Uchucklesit or Alberni Harbour to Nanaimo and Port Augusta, for collecting goods at each of these ports and so tapping the produce of the numerous Inlets, etc., which could be brought round for export to either of these harbours in Barclay Sound.

Steamers could easily run from Waddington terminus to Port Augusta which is only about 80 miles, pending a furthei extension of railway when the resources of the country are more developed.

Uchuchlesit Harbour is very capacious; entirely land locked; is 3 miles long by $1\frac{1}{2}$ miles broad, and would hold a great number of ships.

A floating dock, much required and very easily constructed without entailing much expense, should be provided by Government It would soon pay itself, as the docking would be much cheaper than at San Francisco; further, a coaling depot for Ocean steamers could be made here; the coal to be brought round in small craft from Nanaimo or by rail.

The sea, bays and rivers team with fish, including Salmon, of numerous descriptions (numbers of Salmon at a certain time of year are found on the banks of the Frazer River, laying dead, and stink for miles), Haddock, Whiting, Rock Cod, Cod, Skates, Bass, Flatfish, Anchovy, Herrings, Hoolakan and Halibut abound. The Hoolakan is about the size of a herring, but smaller, from which is extracted an oil, very similar to cod-liver oil,very nutricious. So rich are these fish that the natives often use them as a torch.

To illustrate the abundance of the Hoolakan, I may mention that the natives literally comb them out of the sea into their boats with a long thin pole, through which nails are driven, thus forming the teeth.

The Halibut can be caught in immense numbers round the entire coast. I was informed that a vessel of 400 tons could easily be filled in 48 hours, off San Juan de Fuca Straits; the same fish are in abundance and also a nice kind of Cod, off Metlah Catlah.

Sturgeon are found in the Fraser and Naas Rivers, varying from 100 to 500 lbs. Caviare and Isinglass could easily be manufactured, the former from its roes, and the latter from the swimming bladder.

In conclusion I would beg to remark that if fisheries were established from Naas to Fraser River, it would increase emigration to this part of the Dominion, which would in time develope the other resources of the country, which I believe to be considerable, especially in minerals.

Commander Pender.---For reasons given in No. 27, Burrard Inlet is, in my opinion, preferable to either of the other places named; it is also the most easy of access from the ocean; but even here the risks attending navigating with large steamships, against time, amongst the islands lying between Fuca Strait and the Strait of Georgia, are to me, very great.

The other places appear to stand in the following order of preference, viz:---Howe Sound, Bute Inlet, Bentinck Arm, Dean Inlet, Gardner Channel and Skeena River.

On the three approaches from seaward, I would observe the southern (No. 1) is so well defined, charted, and lighted as to be made present use of by any class of ships.

The middle channel (No. 2).—The position of Vancouver shore may be confidently trusted, but Cape James has not been accurately defined.

The northern channel (No. 3).—The shores of Alaska, as well as Queen Charlotte Islands are unsurveyed, and Rose Spit would always be a large element of danger in using this route.

Lieutenant Collins.—I have not sufficient knowledge of the mainland to enable me to give an opinion.

Abstract of Distances referred to in Questions Nos. 1, 2 and 3.

	Southern	Middle	Northern	Dif. between Southern and Middle	Dif. between Southern and Northern
Cochrane.........	4,300	4,000	3,820	300	480
Richards..........	4,115	3,870	3,694	245	421
Farquhar.........	....	....	....	....	....
Graham...	4,103	3,855	3,678	248	425
Cator..............	4,300	4,052	3,893	248	407
Pender.....	4,300	4,000	3,820	300	480
Collins...........	....	....	....	....	....
Means.......	4,224	3,956	3,781	268	443

TABLE OF DISTANCES from Yokohama *viâ* Northern Channel to

Authorities.	Triumph Bay, Gardner Inlet, viâ Principe Channel.		Triumph Bay, Gardner Inlet, viâ Brown Passage, &c.		Port Essington viâ Brown Passage.	
	Distance.	Towage.	Distance.	Towage.	Distance.	Towage.
Cochrane	4,010	...	4,005	...	3,933	...
Richards	...	...	...	...	3,814	60
Farquhar	...	...	...	...	...	...
Graham	3,928	90	3,898	100	3,794	...
Cator	4,093	100	4,093	130	4,013	30
Pender	4,010	90	4,005	115	3,933	43
Collins	...	...	...	...	...	...
Means	4,010	93	4,000	115	3,897	44
To Kemano Bay, 20 miles to be added	4,030	113	4,020	135	...	...

TABLE OF DISTANCES from Yokohama *viâ* Middle Channel to

Authorities.	Burrard Inlet.		Howe Sound.		Waddington Harbour.		N. Bentinck Arm viâ Fitzhugh Sound.		N. Bentinck Arm viâ Milbank Sound.		Head of Dean Channel viâ Milbank Sound.		Triumph Bay, Gardner Inlet, viâ Milbank Sound.	
	Dist. — Miles.	Towage. — Miles.	Dist. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.
Cochrane	4,320	....	4,315	....	4,275	....	4,160	....	4,155	....	4,160	....	4,170	....
Richards	4,190	320	4,185	315	4,110	240	4,020	150	4,010	140	4,000	130	....	....
Farquhar	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Graham	4,135	130	4,120	150	4,065	160	4,003	88	4,000	90	3,995	60	4,020	64
Cator	4,312	160	4,327	160	4,272	160	4,212	100	4,202	80	4,187	70	4,222	100
Pender	4,320	305	4,315	200	4,275	260	4,160	75	4,155	85	4,160	90	4,170	95
Collins	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Means	4,255	228	4,252	206	4,200	205	4,111	103	4,104	99	4,100	87	4,145	86

TABLE OF DISTANCES from Yokohama *viâ* Southern Channel to

Authorities.	Burrard Inlet.		English Bay.		Howe Sound.		Waddington Harbour.	
	Distance. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.	Distance. — Miles.	Towage. — Miles.	Distance — Miles.	Towage. — Miles.
Cochrane	4,440	......	4,420	......	4,445	......	4,545	......
Richards	4,280	90	4,260	70	4,280	90	4,385	195
Farquhar	......	......	......	......	......	......	......	......
Graham	4,268	......	4,243	......	4,318	30	4,403	40
Cator	4,442	62	4,430	50	4,450	50	4,560	100
Pender	4,440	90	4,420	70	4,445	95	4,545	195
Collins	......	......	......	......	......	......	......	......
Means	4,374	81	4,355	63	4,387	66	4,488	133

APPENDIX V.

LETTERS AND STATEMENTS RESPECTING SOME OF THE HARBOURS AND WATERS OF THE MAINLAND OF BRITISH COLUMBIA AND VANCOUVER ISLAND, BY MASTER MARINERS, PILOTS, AND OTHERS, RESIDENT IN THE PROVINCE OR LOCALLY ENGAGED.

Letter addressed to the Governor General by Captain James Cooper, respecting the sea approaches to British Columbia and certain of the Harbours on the Coast.

VICTORIA, 6th February, 1877.

YOUR EXCELLENCY,—I have the honor respectfully to submit for Your Excellency's information, the subjoined remarks on the sea approaches to the various ports and inlets in this Province, respecting which more or less conflicting statements have been made pending the consideration, by the Dominion Government, as to which possesses the greatest claim for the terminus of the Canadian Pacific Railway.

I am encouraged to address Your Excellency on this subject, from the fact of your recent visit to this Province, and your personal inspection of the inland channels, and the conviction that the localities mentioned will be at once familiar to Your Excellency without further reference.

My attention having been called to this important consideration by ascertaining that a series of questions in form have been transmitted to His Honor the Lieutenant Governor to secure the opinions of some practical seafaring persons respecting the above approaches, I propose to respectfully submit to Your Excellency a plain statement of facts, according to my judgment, based on long experience, in connection with the inland navigation on the coasts of this Province; and so important do I consider this subject that I must beg Your Excellency to allow me to place my opinions with reference thereto on record.

I am a master mariner, and have been connected with shipping in British Columbia, in various capacities, for upwards of thirty years. In my official capacity I have been frequently called upon by the former Colonial Government of British Columbia to render assistance to Her Majesty's ships cruising on these coasts. I have a good general knowledge of all the harbours and inlets from the 49th parallel to the northern limits of this Province.

These facts ought to qualify me to give an intelligent opinion.

I presume the object of issuing the questions referred to is to elicit practical opinions, in order that the Government may be guided in their determinations in fixing the terminus at the port having the greatest general advantages for such purposes.

Transcontinental lines have been projected to each of the following inlets:—

Burrard Inlet.	Howe Sound.
Bute Inlet.	North Bentinck Arm.
Dean Channel.	Gardner's Inlet.
Skeena.	

I shall, however, confine my remarks, mainly, to the sea approaches to the above places, which sea approaches are, in my judgment, the first essential consideration in finally deciding upon a terminus site for the railway.

The Pacific coast is not generally favoured, like the Atlantic coast of this continent, by possessing banks of soundings, the value of which to mariners requires no comment from me. Fortunate exceptions to this rule are the soundings off the West coast of Vancouver Island which render the approach of shipping to the entrance of the Straits of Juan de Fuca at the south and to Goletas Channel at the north (when

the facilities of lights and fog-whistles should be erected) practicable at all times, even in thick or foggy weather. The soundings extend from the shore more or less to the extreme westerly end of the island and about thirty miles to the westward of Cape Scott.

The geographical features of the Straits of Juan de Fuca are most important to the commercial interests of the north-west coast of America, carrying an average breadth of ten miles for fifty miles from their entrance at Cape Flattery to Race Rocks, where, in consequence of the American shore trending northward, the breadth is contracted about two miles. From this point the Vancouver shore recedes in a northerly direction for nine miles towards Esquimalt, off which port the "Royal Roads" extend for three miles, offering to all vessels bound northward a splendid anchorage and stopping place when required. From the Royal Roads (though as a rule not necessarily so) sailing ceases and steaming begins. In the inland waters the winds are generally variable and light, and it is found by experience that steam is practically more economical than attempting to make passages under canvas. Vessels do, however, frequently make the passage to and from the lumber and coal depôts without the assistance of steam.

The next main entrance to the inland navigation is Queen Charlotte Sound, at the extreme north-western end of Vancouver Island to Goletas Channel; approaching which from seaward a vessel would find irregular soundings about thirty miles from shore. When once the land is made there is a good entrance into the channel, which averages a mile and a half in breadth for a distance of fifteen miles. From this point, the channel widens until the west end of Malcolm Island (thirty-six miles from the entrance) is reached; at this place it would be necessary for a sailing vessel to have the assistance of steam. Should this channel be brought into use at any time, it would be found desirable to take steam from the entrance; there are, however, no obstacles in the way of vessels sailing with favourable winds, making the point above indicated.

The navigation from the north-western end of Vancouver Island is good for vessels navigating under or by the assistance of steam, to any port or inlet to the southward and eastward, whether Bute Inlet, Howe Sound or Burrard Inlet; the channels are deep, and no dangers existing other than those that are well known and defined, and which can easily be avoided. Anchorages on the direct line of route in Johnston's Straits can be made in several localities.

A vessel in the offing in Queen Charlotte's Sound, and bound up Fitzhugh Sound, could only approach the shore under most favourable circumstances. The marine surveyors have described a circle about twenty-five miles diameter, designated dangerous ground, round numerous rocks and reefs, which virtually block the entrance to said Sound, leaving two narrow and intricate channels round the circle of dangers that could only be used in clear weather. Fitzhugh Sound is, nevertheless, one of the entrances leading to Dean Channel and North Bentinck Arm.

Milbank Sound may be considered the main entrance from sea, leading to Dean Channel, North Bentinck Arm and Gardner's Inlet, and to this locality I most respectfully beg leave to draw Your Excellency's attention. An inspection of the chart will show a rugged coast line, with only very irregular soundings to be got close in shore. Allow me the privilege of an old sailor to ask Your Excellency what any mariner would do approaching such a place in a gale of wind, in thick weather (to which this locality is exceedingly liable)? He must necessarily heave to, and remain hove to (as it would be impossible to approach the coast under such circumstances with any degree of safety) until the weather should break, which may be for several days; this would at least be inconvenient, say to a steamer having on board Her Majesty's mails, and probably several hundred passengers, bound across the continent; and assuming that the vessel in question finally reaches the shelter of Milbank Sound, it is ninety-five miles to what is called the anchorage (?) at Kamsquot, head of Dean Channel, through winding and circuitous passages with scarcely an anchorage for the whole distance that the commander of a valuable steamship would risk his ship to swing in. It is questionable whether any insurance officers

would take the risk on such navigation. I state this merely as my opinion. A vessel having entered the Sound could, however, without prejudice to the above statement, reach any part of the above-mentioned localities under or with the assistance of steam.

It is, in my opinion, the want of soundings and the danger of the sea approaches that would condemn this route in the judgment of any practical seaman, having in view the purposes for which this entrance might be selected.

With reference to the northern entrances, *viâ* Dixon's Entrance, Brown's Passage and Chatham Sound, leading to Skeena and Gardner's Inlet; the navigation referred to in this locality may be considered only adapted to that of steam. Brown's Passage, so called, is three and a-half miles wide; it has, however, an extensive reef of rocks nearly in the centre, which contracts the passage on the southern side of said reef to two miles, and barely one mile and a-half in the clear on the northern side. To a vessel approaching from sea very great caution would be necessary, as in thick weather this passage would at least be hazardous. (It might be a question for consideration, whether the channel to the north of Dundas Island or that of Edye Passage to the south of Brown's Passage would not offer greater facilities for entering into Chatham Sound; the navigation inside Queen Charlotte's Island being sheltered from the westerly winds, and only exposed to the south-east. Winds, however, from this quarter, with thick weather and rain, prevail during the greater portion of the six winter months. One advantage a vessel would have in using the Edye Passage route *viâ* Cape St. James, would be the soundings inside Queen Charlotte Island.)

When once a vessel has reached the smooth water of Chatham Sound the difficulties of navigation are comparatively light, and from this point to Port Essington the distance *viâ* south end of Kennedy Island is fifty miles; here the sands at the mouth of the Skeena are met with. No survey (to my knowledge) has been made of Port Essington; it is, however, a bar harbour and freezes up solid in winter.

From Gardner's Inlet to Brown's Passage is smooth water navigation, and is one hundred and sixty miles distance to the head of the inlet. In nearly all the inlets and arms of the sea on the coast of British Columbia, one or more mountain streams empty at the head of each, and in severe winters considerable ice forms. At Gardner's Inlet, where, in the months of February and March, 1876, the Dominion steamer "Sir James Douglas" wintered, waiting upon a party of surveyors, ice had formed solid twenty inches thick, extending seventy-five miles down the inlet. The inlet was frozen on the vessel's arrival there, and sixty days afterwards when the steamer left it had not broken up. The only anchorage that could be found in Gardner's Inlet was a small bay, in which room only could be found for the Dominion steamer to lie in, moored head and stern.

The same remarks would apply to Bute Inlet and Howe Sound. I have myself seen ice in the latter place at the head of the Sound, in the month of March, fourteen inches thick.

I did not intend, when commencing this communication, to deviate from the subject of the various sea approaches; perhaps it would, however, with Your Excellency's permission, be desirable to comment upon the harbours comparatively to each other, for Your Excellency's information, having in view the object desired, viz., the terminus of the Canadian Pacific Railway.

I have endeavoured to show to Your Excellency what, in my judgment, are the superior advantages which the Straits of Juan de Fuca possess over the other entrances to the inland navigation on the coasts of British Columbia; this being so, which I feel assured cannot be refuted, it becomes then a question as to which port merits a decision in its favour for the terminus, Bute or Burrard Inlet.

It has been demonstrated that Burrard Inlet is a safe and commodious harbour, for since the establishment of the two large saw mills in that port, the first in 1864, at least six hundred ships of large tonnage, to say nothing of local and smaller craft, have entered to load and have left the port, not one of which received any damage; and the casualties incident to navigation in the inland waters would compare most

favourably with any port in the world. Ice does not form in any part of the inlet proper, as no streams of any magnitude empty themselves therein, except at the head of the north arm of said inlet, which is a comparatively useless sheet of water; and should the inlet be selected by the Dominion Government as the site for the terminus, it may, some day, be considered advisable to block up the arm in question at its narrowest part, which does not exceed twenty fathoms in depth and about six hundred yards across. This may appear a work of magnitude, which, undoubtedly, it is; but, if done, it would have the effect of reducing the current at the entrance of the inlet, probably one-half or two-thirds its present velocity; and it may be fairly asked if it is worth so many millions to make a transcontinental line, it surely would be worth a few hundred thousand dollars additional to make the natural advantages which the inlet possesses as nearly perfect as possible. The inlet as it is, however, possesses all the requirements likely to be necessary, if required for the terminus.

One common road for the inland navigation from the Straits of Juan de Fuca, *viâ* the Haro Straits, which has two separate and distinct navigable channels, through both of which any sized ship could pass. (The channel nearest to Vancouver Island, which could be used if required, would lead a ship at a minimum distance of four and a half miles from the American possessions), continuing through Active Pass direct to Burrard Inlet, Howe Sound, or to Bute Inlet, with this difference, that Bute Inlet is one hundred and seventy miles further up the coast, the latter half of which distance would, in thick weather, be at least very intricate navigation. Waddington Harbour, so called, at the head of Bute Inlet, is really no harbour at all, the anchorage being limited and exposed; and, from the nature of the bottom, it is, in my opinion, beyond the power of engineering skill to make the port secure within any reasonable amount of expenditure commensurate with the object gained. Howe Sound does not possess an anchorage that could be available for any purposes connected with a terminus; the water is everywhere deep and the shore precipitous.

I beg to append a schedule showing the distances of the respective ports and inlets from Yokohama, from which it will be readily seen that notwithstanding the extreme northern routes have considerable in their favour in point of distance, they lack other considerations which, in my opinion, more than counteract the apparent advantages this saving of distance would be in an ocean route. It is in the southern portion of the Province that the resources are being developed, not the least of which are the coal fields of Vancouver Island, an important consideration when ocean steamers have to be supplied, and although an extreme northern route (if practicable with good sea approaches, possessing a favourable port and other climatic considerations) would reduce the distance by water between the extreme northern and extreme southern locality in the Province about 350 miles, it is a question for the consideration of the Government whether that reduction in distance is an equivalent for the facilities offered, as presented herein, leaving out the preponderating advantages of a splendid climate *per contra* of that of the northern portion of the Province.

In drafting this communication, I have duly considered the importance which it bears to the general interest of the Dominion, and have consequently been extremely careful to present nothing to Your Excellency but facts, to the best of my experience and judgment, which I most respectfully submit for Your Excellency's consideration.

I have the honour to be, Your Excellency,

Your most obedient, humble servant,

JAMES COOPER.

SCHEDULE OF DISTANCES.

Viâ Dixon's Entrance and Brown's Passage.

From Yokahama to Port Essington	3,975
" head of Gardner's Inlet	4,085

Viâ Milbank Sound.

From Yokohama to head of Dean Channel..........................	4,173
" " Gardner's Inlet.........	4,221
" to North Bentinck Arm...........................	4,168

Viâ Fitz-Hugh Sound.

From Yokohama to head of Dean Channel......................	4,191
" to North Bentinck Arm............................	4,176

Viâ Goletas Channel.

From Yokohama to head of Bute Inlet, *viâ* Stewart Island..	4,250
" " " Cape Mudge.....	4,273
" " Howe Sound..........................	4,324
" " Burrard Inlet....	4,316

Viâ Straits Juan de Fuca.

From Yokohama to head Burrard Inlet, *via* Active Pass....	4,432
" Howe Sound "	4,440
" Bute Inlet "	4,553
" to San Francisco..................................	4,731

Statement of Captain John Devereux respecting Harbours in the Strait of Georgia and on the West Coast of Vancouver Island.

Burrard Inlet has a safe and commodious anchorage two miles inside the first narrows at Coal Harbour, also another seven miles inside the second narrows at Port Moody, twelve miles from the entrance ; but there is one great objection to either of those places, viz.: both the first and second narrows, respectively, are but about a cable and a half wide, through which the tide runs about nine knots an hour, creating whirls and eddies, rendering it unsafe for large steamers to enter or leave port at night, or at certain stages of the tide, leaving out altogether interruption by fogs and thick weather which occur more frequently inside than out.

Next is the outer harbour of Burrard Inlet, known as English Bay; there, at a place marked on the chart as Government Reserve, is a good anchorage with every facility to construct a breakwater and wharves, or even docks both wet and dry, and by erecting a lighthouse on Passage Island entrance to Howe Sound, one on East Point, one on Twin Point, and another on Discovery Island, the largest ships in the world might be conducted thither in safety ; but there are three months in the year, viz.: from part of August to the same time in November, when this coast is subject to dense fogs, rendering it unsafe, if not utterly impossible to navigate Haro Strait, and the Gulf of Georgia with large steamers such as the Royal Mail, Cunard and Pacific Mail Company's ships.

This point, I think, will be conceded by all who know anything about such ships and the straits in question, where the tide runs from four to six knots an hour, with boiling rips and overfalls, narrow channels and outlying reefs, deep water and no anchorage that could be reached in such weather, and to stop a stream in such a plight would simply mean to the mariner to lose his reckoning, as he would be carried off by the tide, and not know whither to go; on the other hand if the engines of a large ship were kept going like those of the small steamers on this coast, she would neither answer to her helm nor turn astern quick enough to avoid running ashore, as it frequently happens; the fogs are so dense here that land cannot be seen one hundred yards off.

Such is a brief description of the difficulties the navigator would have to contend with in these inland waters, and the farther up the Strait of Georgia he would proceed, the more he would add to his troubles; therefore, I will not dwell on this subject by describing anything above Burrard Inlet.

I will now call your attention to the west coast of Vancouver Island where nature would seem to have revelled in harbor making, that it might almost be said they are innumerable, but strange to say out of so many there is not one, except perhaps Hesquiat near Nootka Sound, and Uchucklesit in Barclay Sound, worth noticing for such a purpose, on account of deep water, narrow channels and poor accommodation within, with rocks and outlying dangers without, whereon ships would strike in thick weather whilst seeking entrance; however, the tides are more regular on the west coast than inside, and might be relied on at all times, but as a set off against this, bad weather happens more frequently, or at all events is felt more on account of the heavy seas and exposure to the lash of the Pacific Ocean.

And now to return to those harbours above mentioned. Hesquiat has but twenty-four feet of water on the bar at low water, whereon the sea breaks heavily during south and south-west gales, rendering it impracticable for large steamers to enter or leave port during their prevalence, and even in fine weather there would be no water to spare for such vessels as the "Shannon," "Siene," "Tasmanian," of the Royal line, drawing over twenty-three and a half feet when loaded, therefore the above port would be ill adapted to such a purpose.

And now for Uchucklesit, in Barclay Sound, about 15 miles inside of Cape Beale.

The channel leading to this harbour is narrow, varying from one to two miles in width, has water too deep to anchor, and several dangerous rocks that would be difficult to avoid in thick weather, and the harbour itself has also very deep water with little accommodation for such an important station.

And there is still another and greater disadvantage on the west coast (*i. e.*): the further north the mariner proceeds along the coast the less distance the soundings extend from the shore, consequently he has not the facilities at hand in thick weather there as he would have farther south, to warn him of his approach to the land and its attending dangers.

It will be now seen that, in my opinion, either Esquimalt must be made the terminus of the ocean steamers or else a harbour must be sought north of Vancouver Island altogether, where there is neither settlement or any other advantage to offer as a recommendation; so everything seems to be in favour of the former, viz., settlements, political and commercial importance, and a naval station, which it both now is, and ever will be, notwithstanding others to the contrary: for as long as England and the Dominion require a navy to protect their interests on the seas, Esquimalt will be the station on the Pacific, in order to watch the Strait of De Fuca, and political movements on Puget Sound. So if St. Juan Island be the key to British Columbia, Esquimalt is the lock; and the latter may still keep the thief out of the house, even if the key were lost.

And as to its capabilities as a fort, it is needless to mention them; but for the benefit of those who are not well acquainted with nautical matters, I will remind them of last summer when the fleet on this station, together with the Flying Squadron, were all anchored safely in it, leaving room for as many more, independently of the shores where wharf accomodation could be constructed for double the number. Such is the harbour, and its approaches are equally good and clear.

Without, is an excellent outer harbour, "Royal Roads," where ships ride in all weathers. It has also a lighthouse erected at its entrance, with another at Race Rocks, leading to it, but to render the chain complete and navigation safe and easy there should be one built on an unnamed point near Jordan River, half-way between Cape Flattery on the one side, and the above rocks on the other, and another on Cape Beale, entrance to Barclay Sound.

The mariner then coming in from the Pacific could sight the latter, also Cape Flattery, Jordan River. Race Rocks, by the way, and Esquimalt.

In making the land in thick weather, he has soundings to a distance of

thirty miles off shore, and nowhere else on this coast are such soundings to be found. In fact, it is to the Straits of De Fuca what the Banks of Newfoundland are to the Gulf of St. Lawrence, a safe and valuable guide to the mariner approaching the land in thick weather, and by attending to the lead, and using ordinary precautions, the navigator can find his way into and through the Strait, as there is a deep water zone, 100 fathoms, running eastward mid-channel until Race Rocks are passed, where it shoals to 60 or 70 fathoms. This deep water shoals rapidly to twenty fathoms about two miles off shore on both sides of the Straits, and at a distance of one mile, six to ten fathoms will be found, and carried right up to the cliffs, as there are no outlying dangers except Race Rocks, where there is already a lighthouse, as above mentioned, and a fog bell, and where there would be placed a gun to fire every half-hour during fogs, similar to those in the St. Lawrence.

But even without the gun, the mariner could steer mid-channel by the lead until the water shoaled eastward of Race Rocks, and thence one course would take him in safety to Royal Roads, where the mail or passengers could be landed night or day.

In conclusion, I may add that a steamer might, in fogs, anchor a mile or so off shore on the Vancouver side, anywhere from Port San Juan to Sooke, a distance of thirty miles, in from six to seven fathoms of water, as it seldom happens that there is much wind with fogs on this coast, and the sea, however light it may be, gives forth a distinct peculiar sound, while washing against the cliffs, sufficient to warn the mariner of his proximity to the shore.

JOHN DEVEREUX.

Statement of Captain Brown, of the Schooner "Alert," respecting Barclay Sound, Stamp Harbour (Alberni) and Uchucklesit.

Captain Brown states that he has been engaged in the coasting trade of Vancouver Island, between Victoria and Barclay Sound, for the past twelve years, and that he at one time was pilot on the Sound, and has taken several large sailing ships to Stamp Harbour. He says it is one of the best and safest on the Pacific coast, and he has seen ten large sailing ships in there at one time, and six of them were able to lie alongside of the mill and load at once. The anchorage comprises an area of about two miles square, and a depth of from ten to twenty fathoms. Vessels of any size can ride at anchor in any gale of wind in perfect safety, and he feels confident that in Stamp Harbour six times as many vessels can lie at anchor as in Esquimalt. Barclay Sound can always be approached in foggy weather by soundings, and there is now a lighthouse at Cape Beale. The rules laid down in the Vancouver Island Pilot are correct, and there are some small anchorages in Barclay Sound not laid down on the chart. A vessel can sail from the entrance of the Sound to Turn Island and find good anchorage there, but as the wind is nearly always baffling, a steam tug must be used to tow her thence to Stamp Harbour.

Uchucklesit is a good harbour, but is out of the way for a vessel unless she has a tug, on account of baffling winds.

In going up the Alberni Canal the only current to be met with is that on an ebb tide, and its greatest velocity does not exceed $1\frac{1}{2}$ knots.

Statement of Captain McKay, respecting Barclay Sound, Alberni Canal.

VICTORIA, 10th January, 1874.

Captain McKay states that Barclay Sound is easy of approach, as easy as most coast places. The entrance to the Sound is good and soundings outside; good anchorage inside. Stamp Harbour, he says, is an excellent harbour, well sheltered and safe, with plenty of good anchorage. Alberni Canal has deep

water, but is free from danger. If any traffic were there, steam tugs would be used as they are in other places, not as a matter of absolute necessity, but as a matter of convenience. In the case of steamers plying here there would be no difficulty whether in or at the entrance to Barclay Sound or Stamp Harbour.

Statement of Captain Christian, Pilot, respecting Barclay Sound and Alberni.

Captain Christian is a pilot and has been on the north-west coast of Vancouver Island during the past eleven years; knows Barclay Sound; has been there coasting hundred of times, *i.e.* nearly every month at least. There is a good navigable entrance, one $2\frac{1}{2}$ miles, another $1\frac{1}{2}$, the third one mile. There are some dangerous rocks outside, but plenty of room to avoid them; they are down on the chart. There are soundings outside extending about one-half mile from the shore about the eastern channel. Barclay Sound is quite safe: the anchorages are not numerous in the Sound. Stamp Harbour is a good harbour, at the head of Alberni; good anchorage and safe; usually requires a long boat with a westerly wind. The light at Cape Beale is very valuable, and anyone acquainted with the place can enter the harbour at night. The current usually sets out. He considers Barclay Sound easy of approach with a fair wind; with a foul one it is like most other places, but there is plenty of sea room.

Statement of Gilbert Sproat respecting Barclay Sound and Alberni.

I know Barclay Sound, but have no personal interest there. Probably, I know it better than any other resident in the Province, for my firm, under my personal management, had saw-mills there for five years, and its navigation question was the question I had to consider.

We had no lighthouse on Cape Beale in those days. I think we loaded about 63 vessels of considerable size at Alberni (Stamp Harbour), which you know is at the head of the canal, and I think I am right in saying that not one sustained any danger. We have had ten ships, of 1,000 tons on the average, lying at one time off the wharf at Alberni. These facts are better than theoretical statements. For a general description of the place I would refer to the Admiralty Chart, but may say that while Barclay Sound is not a harbour like the unrivalled Esquimalt, it is not a bad harbour. The eastern passage is the best, we always considered, and now that there is a lighthouse at Cape Beale it can be well approached.

The channel is only about a mile clear, too narrow for big ships to beat into, but generally the wind draws up or down. We got along for five years without any appliances, and I therefore think that with the lighthouse, a tug boat and pilot, the place would prove to be better than the average harbours on this or on the English coast. The most I know about the harbour at Alberni (head of Canal) is that it was frozen over once 14 years ago, not since, nor for long before, by Indian accounts.

Uchucklesit is a good harbour, quite snug; generally speaking, the water in both the Sound and Canal is too deep, but there are some good anchorages. I have ridden out a gale in Wizard Anchorage, near Satellite Passage, just after you got well into the Eastern passage. There is not an anchorage beyond Uchucklesit in the Canal, but you can lie up alongside the rocks, and the wind generally draws up or down. Once up to Stamp Harbour a dozen or more big ships can ride comfortably.

You could not run into Barclay Sound in a fog, nor could you into the Straits of Fuca with much confidence.

There is a rolling and generally wooded tract of land at head of Canal five or six miles square, with good soil in parts. Very good indications of coal have been found lately close to the wharf. A small expense would make Alberni safe from attack by an enemy from seaward, the canal is so long, narrow, and bordered by such high mountains.

GILBERT SPROAT.

VANCOUVER ISLAND, 4th February, 1877.

APPENDIX W.

MEMORANDUM ON THE MILITARY ASPECT OF THE BURRARD INLET ROUTE, BY MAJOR-GENERAL SELBY SMYTH, COMMANDING THE MILITIA OF CANADA.

There can be no doubt that Route No. 2, terminating at Burrard's Inlet, is open to some military objections upon the ground of its running within a short distance of a foreign territory, for full 60 miles from the sea. Its approach is also liable to interruption from the ocean, in passing the Island of San Juan, but recently, unfortunately, given up to the United States. The guns on this island would completely command the passages either by the Rosario or Haro Channels.

I do not think, however, that the objections I have mentioned—and there are none other of which I am aware—are of sufficient gravity to weigh against the numerous advantages which have been set forth in favour of the Burrard Inlet terminus.

In case of hostilities, we should, in all probability, have a considerable squadron of gunboats and ships of war of various descriptions, upon which we should have to depend, not only to guard the approaches from the ocean, but also to keep open the Frazer River from its confluence with the Strait of Georgia, past New Westminster, to Hope.

Raids, of course, could, and, possibly, would be made from Washington Territory across the international line to tear up rails, blow up bridges, or otherwise interrupt the line of railway; but as in war it is scarcely possible to provide against every sort of desultory attack, so it would hardly be consistent to overlook all the numerous advantages in favour of Burrard's Inlet terminus, merely from fear of eventualities which may be very remote—may, indeed, never occur—or if attempted, might be averted or rendered nugatory, through the means of naval protection to which I have alluded.

E. SELBY SMYTH,

Major-General.

Ottawa, 15th March, 1877.

APPENDIX X.

SKETCH OF THAT PORTION OF CANADA BETWEEN LAKE SUPERIOR AND THE ROCKY MOUNTAINS, WITH SPECIAL REFERENCE TO ITS AGRICULTURAL CAPABILITIES, BY JOHN MACOUN, M.A., PROFESSOR OF BOTANY, ALBERT COLLEGE, BELLEVILLE, ONTARIO.

During the summer of 1869, Professor R. Bell, of the Geological Survey, examined the region around Nepigon River and Lake, and reported that there were large areas of land, both in the vicinity of the lake and river, well situated for agricultural purposes. Speaking of the Nepigon country, he says: "In the Nepigon country the largest tract of good land appears to be on the south-western side of the lake. From the Nonwaten River northward to the Pagitchigama, a distance of fifty miles, the country is comparatively level, and the soil generally fertile; but we could not ascertain from our own explorations how far westward this tract extends. The Indians, and others, however, represent it as continuing nearly to the River Winnipeg, and becoming more generally level in receding from Lake Nepigon. Some of the peninsulas in Lake Nepigon, within the above distance, are hilly; but the soil, generally, is good, even on these, consisting of a brownish loam sufficiently tenacious, when moist, to retain its form after being pressed in the hand. The rivers entering this part of Lake Nepigon, as far as examined, were found to flow, with tortuous courses, between muddy banks of clay, overspread with fine sand. The clay as seen in the banks generally appears sandy from having become mixed with the overlying deposit; but when clean sections are obtained, it is usually found to be stiff, tenacious, and free from grit. On the higher levels the sand is often coarser, and stratified with layers of gravel.

There is a considerable area of good land around the bottom of South and McIntyre's Bays, and on the peninsulas east of the latter bay and Gull Bay. From the mouth to the first rapid on the Poshkokagan, the loamy banks of the river are from twenty to thirty feet high. The River Kabitotiquia is so crooked that by following its windings from the mouth to the portage leading to Chief's Bay, the distance was estimated to be fully thirty miles, although it is only nine miles in a straight course. On both sides the country is level and the soil sandy, supporting a growth of grass and bushes, the timber having been all burnt off by repeated fires within the last few years. The land is free from stones, and very little labour would be necessary to make it ready for the plough."

A number of other localities are mentioned having a good soil, and capable of supporting a large population.

During the summer of 1869 I made extensive collections of the plants in the immediate vicinity of Lake Superior and at some distance from its shores, and in no case did I find boreal plants except close to the Lake. Although the greater part of the land was covered with spruce it was quite evident that if this were cleared away the land would be drier and a different vegetation would spring up. In the summer of 1870 very extensive fires took place, and much of this timber was consumed. My second visit confirmed the opinion I had formed on my first that the apparent coldness of the Lake Superior region was caused by a super-abundance of moisture. Even three years had made a change, and the vegetation now springing up was indicative of a drier climate. The valley of the Kaministiquia contains a large quantity of good, fertile soil and the greater part of the land between Thunder Bay and Shebandowan will yet produce heavy crops of hay and oats, and possibly wheat. When passing through it in 1872 I noted that all the attempts which had been made at cultivation had been successful. Timothy was exceptionally good and produced immense

quantities of seed. I have no doubt but that much of the land on the eastern side of the watershed is suitable for cultivation, and that, taken as a whole, it is little behind many parts of the Laurentian country in Ontario.

I have very little knowledge of the country which I designate as the "watershed." It seems to be a plateau elevated about 1,000 feet above the Lake, and so studded with lakes as to appear to be at least one-half water. There can be very little land fit for cultivation; judging from the section passed over by me, I am led to assume that there are extensive groves of red and white pine throughout the whole area. That this is so, I have no means of proving, but I infer it from the country to the south of it—Minnesota—which, in its northern part, is precisely like the area in question. This section may be said to extend from the Minnesota boundary on the south, to English River on the north; and from the Lake of the Woods on the west, to near Lakes Nepigon and Superior, on the east.

An area of more or less extent, well suited for agricultural purposes, is met with on Rainy River; but whether it extends far to the north, seems to be an open question. A gentleman, who resides at Fort Francis, informs me, that there is much more good land along the river than is generally supposed, and that it extends a long distance back from it. There are likewise many fine groves of first-class timber, and he assures me that there can be no doubt of the fertility of the soil, as crops of all kinds are raised at Fort Francis. Here, there will be a very large settlement, which will very possibly extend back, in coming years, to the railway. This is the most favourable point for settlement between Lake Superior and Manitoba; and as it is in connection with navigable water, will always be an important location. The swamp said to extend along the right bank of the river, at a varying distance of from one to thirteen miles, will be very easily drained, as it is much higher than it. As the country is cleared, these swamps will naturally dry up, as they are really formed by the deposition of moisture in excess of evaporation, which will not be the case when the summer wind gets free play. It may be set down as reliable, that all the land in this region not covered by rock or sand, is good; and that the extent of this good land is in excess of the amount conjectured.

Without a doubt, the whole region from Thunder Bay to Lake Winnipeg, contains a large amount of fertile soil; and from the nature of the forest-growth, there can be little difference between its climate and that of Northern Ontario. White pine, red pine, swamp elm, red ash, red and white oak, balm of Gilead, poplar, basswood, birch, spruce, cedar, and tamarac abound, and grow in many cases to a large size. A comparison between this region and that of northern Ontario, is not inapt, as the parallelism is almost complete. Rocky ledges, swamps, lakelets, patches of good arable land, larger areas of good or sandy soil, lakes and rivers teeming with fish, and, lastly, a climate cooler and moister than that of the Lake region, are found throughout both areas.

Taking the average width of the dry land along Rainy River at eight miles, and its length at eighty, the valley cannot contain an area of less than 300,000 acres of good land, having a soil so rich that it has been the theme of every explorer. The canal now being built at Fort Francis will do much to attract settlement to this out-of-the-way region, and will be a valuable auxiliary in the construction of the Pacific Railway.

Although Winnipeg River is very rocky, yet along its course there are many small areas which have a very fertile soil, and which produce Indian corn and wheat together with other cereals in abundance. Towards the mouth of the river the good land increases, and at Fort Alexander there are many thousand acres of good arable land.

A region very little known lies between Lake Winnipeg on the one hand, and Lakes Manitoba and Winnipegoosis on the other. Its climate is certainly no colder than that in the vicinity of Fort Garry, and wherever sufficiently elevated above the lake, it should produce all the cereals cultivated further south. Near the lakes there are immense marshes and low grounds which produce great quantities of hay, and which, on the settlement of the country, will be very valuable both for pasture and meadow lands.

The greater part of the country between the Duck, Porcupine and Riding Mountains on the west, and Lakes Winnipegoosis and Manitoba on the east, is very wet and marshy. This may be said to be the cause of the summer frosts in this region. Although marshy and wet the soil is nearly all good, and in coming years, when properly drained, will produce abundant crops. A careful examination of the map will show the reason of this wetness. This is the outer margin of the "First Prairie Steppe," and the water which has been absorbed into the soil of the "Second Prairie Steppe" here comes to the surface in multitudes of springs, which are the cause of the marshes that lie along the base of the mountains spoken of above. No one carefully studying the map of the "Second Steppe" can doubt the correctness of this theory.

A line passing from Fort a la Corne and the Basque Hills by the Porcupine, Duck and Riding Mountains and the wet country east of Pine Creek to Pembina Mountain, will include the country known as the "First Prairie Steppe." East of Red River this same region extends along the boundary to near the North-West Angle and north to Lake Winnipeg. The outer line all the way round is marshy, except where it is cut through by the Red River, and in course of time will all be drained and become very productive.

Taking Manitoba as a whole, it is surpassed in fertility of soil and productiveness by no other country in America. From a careful study of its rainfall and its natural productions, I have no hesitation in saying that all our forest trees will be easily grown on any part of the "First Prairie Steppe." There seems to be no deficiency in the rainfall in spring and summer, although both the fall and winter are very dry compared with ours. Experience of the climate of Manitoba will surely bring a liking for it, it being so uniform that the periods of the commencement and close of winter may be accurately predicted.

Second Prairie Steppe.

On the Second Prairie Steppe, the soil, instead of being uniform as on the first, changes its character very often. Rich prairie soil is found, alternating with gravel, sand, or boulders, or with a mixture of all three. My own observations made during two trips across it are as follows :—

After passing Rat Creek, the trail to Pine Creek leads over a wide and beautiful prairie, (in 1872 without an inhabitant, but in the fall of 1875 nearly all fenced in and studded with the houses of numerous settlers). For the first few miles the country is an unbroken plain, with, at intervals, a few clumps of aspen. As we proceeded westward, it became more thickly covered with aspen clumps, and gradually changed from a boundless prairie to a partially wooded plain. The trees were very small, in no case being more than six inches in diameter, and having every appearance of quick growth. Constant fires are certainly the cause of the want of wood, which is every year becoming scarcer. After leaving Rat Creek, for a distance of over twelve miles the land is of first-class quality; then intervenes a tract of land about ten miles in extent, which is more wooded and wet in spring, as was easily seen by the numerous clumps of willows thickly scattered over its surface. For the next ten miles the trail led through a rich country; vegetation of every kind being most luxuriant and bearing testimony to its general fertility. The whole of this region was evidently covered with forest at a recent date, as there are oaks and many aspens still remaining. Fires are gradually but surely denuding the whole country of woods, as the margins of all groves show the action of fires. Much that had been green forest land when I crossed with Mr. Fleming in 1872 was now (October 1875) covered with blackened trunks. When within four miles of Pine Creek, the land changes and numerous sand hills are passed which indicate the outer flank of the "Second Prairie Steppe." This sandy tract extends to about four miles west of the creek, and has still many scattered oak trees upon it.

Between Pine Creek and the Little Saskatchewan, a distance of 31 miles, the land is generally good, but wood for the first 20 miles is very scarce. The soil is

drier and warmer than that east of Pine Creek, and although possibly not yielding so much per acre it would still be considered first-class land in the east. As we approach the Little Saskatchewan the land becomes rougher and many small lakes are passed. Many boulders strew the ground and ridges of gravel or sand are occasionally seen.

The valley of the river is very beautiful, and formed a pleasing contrast to the monotonous country passed over before reaching it. The timber on its banks is nearly all destroyed by the recklessness of travellers and hunters, and there is almost a certainty that, before but a very few years have elapsed, there will not be a tree left in the country. The whole of this valley is well suited for cultivation, and there is an abundance of water at all times, and quantities of fish at certain seasons; the only drawback is the want of wood.

Between the Little Saskatchewan and the Salt Lakes, a distance of 25 miles, the land is fit for cultivation but the water is scarce, and in the fall of the year there is none to be had, except by sinking wells, which is out of the question, for travellers.

Shoal Lake, ten miles west of Salt Lake, seems to be the centre of a depression, and for six miles west and twelve miles east of it the land seems to be impregnated with salt, as for the whole eighteen miles saline plants were observed. When I passed the Shoal Lakes in August, 1872, a stream of fresh water was flowing out of the upper lake southward into the lower, and the water was sweet and good. Passing the same point last October, I was surprised to find that the creek had ceased to flow, and that the water in the upper lake was not fit to drink.

This water question is one not easily solved; but from my own observations I have concluded that good water will be found in almost every part of the country by judicious sinking. From the fact that when salt water and fresh are near each other the *fresh* is on the higher ground, I have come to the conclusion that the salt depressions or areas occur either where the soil is impervious, or at the bottom of synclinals. The fact of springs being found higher than the salt seems to point to the latter as the cause. Unquestionably one or other of these is the true reason, as salt lands are generally, at least to all appearance, impervious to moisture. On other parts of the prairies the soil is porous, and the water disappears from the surface, eventually to appear as springs or swamps, it may be, hundreds of miles off. Were wells dug in the vicinity of fresh water pools, or on lines showing an appearance of an anticlinal, water would be invariably obtained.

The soil between Shoal Lake and the Assiniboine is generally good, being principally a sandy loam, resting on a gravelly sub-soil. Limestone pebbles are very abundant in the soil, although there is an abundance of gneiss boulders on the hill-sides and on the level ground also, in a number of places. The country between Bird Tail Creek and the crossing of the Assiniboine is much cut up by deep ravines running down to the river; in consequence of this, much of the land would be unfit for the plough.

The triangular area enclosed between the Assiniboine on the one hand and the Qu'Appelle on the other, having a perpendicular of 25 miles, is worthless for agricultural purposes, being composed of sand or gravel, but after that is passed, the good land continues all the way to and beyond the Touchwood Hills. The hills are more like an upland plateau than anything else. They are about 80 miles wide where the road crosses them, and are simply a series of undulations like broken waves, the hollows being ponds, lakes and marshes. It is only in the vicinity of the "Old Fort" where they are above the general level. They are certainly much higher than the plain to the west, as it is a continuous rise, *going east* for many miles before reaching the hills. The soil on both sides is much better than that of the plateau itself. From ten miles east of Cut Arm Creek to the eastern base of the Touchwood Hills the land is first-class and contains but little salt. Much of it, however, is without wood; but a very few years would suffice to cover the greater part with forest, if the fires could be stopped. East of the Little Touchwood Hills and north of File and Pleasant Mountains stretches a wide undulating plain, with little wood or water, but with an excellent soil. For the most part it consists of a gravelly loam, with from six to ten

inches of the usual black prairie soil on the top. Although there is scarcely any water on the surface, there is no doubt but that the very best could be obtained by sinking, as there is scarcely any brackish water or "salt lands."

After passing the Touchwood Hills, there is a stretch of fully forty miles where there is no wood and scarcely any fresh water. It seems to be an immense depression extending east and west along the base of the hills for a great distance, ending to the eastward in Quill Lake, which is said to be quite salt. Ten miles west of the "Hills" is the bitterest water on the whole route, and at the time I passed it, last October, it was even unfit for either horses or cattle. Twenty miles may be set down as the breadth of the salt lands, the other twenty being a very fair soil, but totally devoid of wood and possessing very little water at any season of the year. Between the eastern edge of the plain and "Round Hill" the soil is very good, but the surface is much broken with hills, ponds and boulders. From Round Hill to the South Saskatchewan—a distance of over fifty miles—the soil is generally of a first-class order. The aspect of the country is much varied by wooded hills and fertile prairies interspersed with beautiful little lakes and occasional marshes; taken as a whole, this region is all well suited for settlement. Round Hill is about four miles west of the telegraph line, and the country seen from its top is thus described by the author of Ocean to Ocean: "Climbing to the summit of the central hill we found ourselves in the middle of a circle, thirty to forty miles in diameter, enclosing about 1,000 square miles of beautiful country. North and east it was undulating, studded with aspen groves and shining with lakes. To the south-west was a level prairie with a sky line of hills bordering it. To the north-west—our direction—the hills gradually descended to the more level prairie beyond, through a beautiful, boldly irregular country, with more open expanses than the Touchwood Hills showed, and more beautiful pools, though the wood was not so artistically grouped."

All that has been said of the country between Pine Creek and the South Saskatchewan applies to the line of cart road, which by referring to the map will be seen to pass across the plateau which separates two water-sheds. On all the land for the whole distance the grass forms a sward, and if the prairie fires were stopped the whole would be again covered with wood without difficulty. The only tree for this whole distance is *Populus tremuloides* (Aspen poplar) except a few oaks, elms and ash, in the valley of the Assiniboine.

The country south of the line I traversed is drier, and almost wholly without wood; but there are many first-class locations in the valleys of the rivers which traverse the territory in question.

George Dawson, Esq., who was geologist to the Boundary Commission during the years 1872, 1873 and 1874, in his published report speaks of this region, the Second Prairie Step, &c., as follows:—" On crossing Pembina River the eastern margin of the great treeless plains is entered on. No woods now appear except those forming narrow belts along the valleys of the streams, and soon even the smaller bushes become rare. The shrubs met with are generally stunted from the absence of shelter against the wind and the frequent passage of prairie fires. With reference to the soil west of Pembina River the same remarks apply as to that east of it. It is fertile, though not so deep or inexhaustible as that of the Red River Valley, and rests on a gravelly drift sub-soil. Swampy bottoms, bearing a good growth of hay grass, abound, but their area is small as compared with that of the dry ground. Toward the end of summer most of these swamps dry up completely, and extensive regions are then without other water supply than that derived from the streams and rivers, which lie in deep valleys and are often far apart. I do not think, however, that difficulty would be found in obtaining water by wells sunk in any of the lower part of the prairie. The rainfall of this region is probably slightly less than that of Red River Valley, but appears to be sufficient for agricultural purposes.

It seems probable that at a period not very remote, a great part of this region was covered with forest trees. The humidity of the soil and climate is sufficient for their growth, and in some places little hummocks, resembling those found in a forest and known as "cradle knolls," were observed. On approaching Turtle Mountain,

the tendency of this part of the prairie to recloth itself is shown by the occurrence of thickets of seedling poplars on the sheltered sides of the undulations, wherever any considerable period has intervened since the ravages of fires. The water of the ponds and swamps of this part of the prairie is generally sweet, but one distinctly saline lake was seen.

Turtle Mountain, forming as it does, a more or less thickly wooded area which may be estimated as over 300 square miles, cannot but be a valuable nucleus for the utilization of the surrounding treeless prairie; serving as a supply of fuel and building timber, and as a refuge for wintering stock which, during the summer, has been herded at large on the plains. Though the elevated and broken area of the "Mountain" is pretty nearly equally divided by the Boundary Line, the northern half is more uniformly covered with woods, and probably embraces two-thirds of the forest area. There are also large regions of the so-called mountain, which, though more boldly undulating than the prairie, show good soil, and will eventually be cleared for agriculture. There are indications that this wooded area receives a much more copious rainfall than the surrounding country.

The wood is chiefly poplar, of two species. Oak, however, occurs abundantly along the margin of the forests, and forms groves on the ridges, or groves interspersed with other trees. White birch is abundant, though not forming large groves, and black birch also occurs. The ash-leaved maple or box elder, and the elm are also found, the latter attaining considerable dimensions in some of the more sheltered valleys. The largest poplars observed must have been over two feet in diameter at the base, and of good height. The average size in many groves is about eighteen inches. The oak and birch are seldom over two feet in diameter, and the latter are generally much less, but growing in thick masses and very tall. Most of the swamps are grassy, and would yield excellent hay. Peas and vetches are abundant and occur with the fireweed (*Epilobium angustifolium*) and various species of Aster and Solidago.

Westward from Turtle Mountain the prairie rapidly loses its abruptly undulating character, and becomes almost perfectly level before reaching the River Souris, at the 170 mile post. There are, however, still many shallow basin-shaped hollows, which must be filled with water in the early spring, but, soon after, show a fine tall growth of swamp grass, which in the autumn was found in many places standing considerably higher than a horse's back, and which contrasts strikingly with the short crisp sod of the surrounding prairie. The vegetable soil is not very deep, often only six or eight inches, and in character somewhat light and sandy, but it is based on whitish marly drift, which forms a good subsoil.

The valley of the Souris is here nearly a mile wide. It includes some flat and very fertile land, and a limited quantity of timber, chiefly elm, is found along the immediate banks of the stream, massed in fine groves on the peninsulas formed by its devious windings.

The region between the first and second crossing of the Souris by the line, about 50 miles in width, presents features similar to those of that last described. It is gently undulating, with a soil which is, in some places, perhaps, rather thin and gravelly, but becomes deeper and richer in the vicinity of the North and South Antler Creeks—tributaries of the Souris. Along the valley of the South Antler, a good belt of trees extends for many miles. The surface is everywhere covered with a strong sod of short grass.

The Souris at its second crossing flows in a valley with wooded grassy banks, somewhat narrower than before, and with the immediate bed of the stream proportionately deeper. It is still fringed with wood and continues to be so as far as Wood End—262 mile post—or about 80 miles by the course of the stream.

From the second crossing of the Souris to the foot of the Missouri Coteau, from the 215th to the 296th mile post, the prairie still shows a gently undulating surface, and in most places a short thick growth of grass. The soil, however, in passing westward shows a tendency to become more sandy and stony, and some large tracts are covered with boulders in such profusion as to be rendered permanently unfit for agriculture."

These are the words which Mr. G. Dawson uses in describing the Second Prairie Steppe as seen by him on the Boundary Line on Latitude 49°.

Between the road travelled by myself and the Boundary so clearly described by Mr. Dawson, flows the Qu'Appelle River, explored by Professor Hind, in 1858. Of the valley of this river and its surroundings, he thus speaks in his report of the country between Fort Ellice and the Qu'Appelle Lakes :

"At 4 p.m., on the 12th of July, we left Fort Ellice, and travelled due west through a pretty country, near the banks of the River Qu'Appelle. We passed one quagmire, and after breakfast on the following day, arrived at the Cross Woods; they consist of aspen, with a splendid undergrowth. The pasturage is excellent and the road good. On the 13th, we passed through a fair rolling country, the soil consisting of sandy loam, with much vegetable matter in the valleys. Aspen groves are numerous, and many little lakes, margined with reeds, afford quiet breeding places for ducks. The road is good in summer, but wet in spring. The trail continued through good land for nine miles, with aspen groves on the crown of each undulation, and willow bushes in the hollows. Then came a prairie, three miles across, but of much greater length. Ponds were numerous, abounding with ducks and ducklings. On the morning of the 15th, we reached a treeless prairie, marked at its western extremity by a sandy ridge, known among the Indians as the West Ridge.

Beyond the West Ridge the country is very undulating and boulders of limestone and gneiss rocks are strewed on the flanks and summits of the hills. In the morning after a clear night we always noticed heavy dew, this phenomenon was not so frequently noticed on the Souris under similar circumstances. There can be little doubt that the aridity and barrenness of the Great Prairie between the Qu'Appelle and the 49th parallel is owing to the small quantity of dew and rain and the occurrence of fires. North of the Qu'Appelle seemed to be far more humid and the vegetation infinitely richer than south of that great valley.

Another prairie eight miles broad succeeded that last described, and bounded by ridges having a N.W. and S.E. direction introduced us on the 16th to a hilly country for some miles. The range is called the Indian Head, and contains many beautiful lakes and is well wooded. Here we met Charles Pratt and a party going to Red River; an old Indian, accompanying Mr. Pratt, born in this part of the country, told us that he remembered the time when the "whole of the prairie through which we had passed since leaving Fort Ellice was one continuous forest." The view from the Indian Head range is exceedingly beautiful; it embraces an extensive area of level prairie to the north, bounded by the Aspen Woods on the borders of the Qu'Appelle valley. A portion of the old forest alluded to by the Indian still exists on this range. It consists of aspens of large growth and thickly set.

On Saturday, the 19th, we entered a very beautiful and fertile prairie at the foot of the Indian Head ridge, our course leading us in a northerly direction to the Qu'-Appelle Mission. We reached it about 6 p.m., after passing through a magnificent prairie all day. In fact, the country north of the Indian Head and Chalk Hill ranges is truly beautiful, and will one day become a very important tract."

Speaking of the country between the Qu'Appelle Lakes and the Elbow of the South Saskatchewan, the same writer says: "Putting out fires in the prairie is a telegraphic mode of communication frequently resorted to by Indians. Its consequences are seen in the destruction of the forest, which once covered an immense area south of the Qu'Appelle and Assiniboine. The aridity of those vast prairies is partly due to this cause. The soil, though light, derives much of its apparent sterility from the annual fires. In low places and in shallow depressions where marshes are formed in spring, the soil is rich, much mixed with vegetable matter and supports a very luxuriant growth of grass. If willows and aspens were allowed to grow over the prairies they would soon be converted into humid tracts in which vegetable matter would accumulate, and a soil adapted to forest trees be formed. If a portion of a prairie escapes fire for a year or two the result is seen in the growth of aspens and willows, first in patches, then in large areas, which in a short time become united and cover the country; thus retarding evaporation and permitting

the accumulation of vegetable matter in the soil. A fire comes, destroys the young forest growth, and establishes a prairie once more. The reclamation of immense areas is not beyond human power. The extension of the prairie is evidently due to fire, and the fires are caused by Indians, chiefly for the purpose of telegraphic communication or to divert the buffalo from the course they may be taking. These operations will cease as the Indians and buffalo diminish; events which are taking place with great rapidity."

Prof. Bell, of the Geological Survey, examined the country in the neighbourhood of Fort Pelly during the summer of 1874, and thus speaks of the timber and soil between Duck Mountain and the Assiniboine:—"Following a south-east course from the Crow Stand, I first passed along the south-eastern base of a bouldery ridge, about a mile in length, having the same direction, and at the end of 11 miles came upon Big Boggy Creek, flowing north-east. This I descended for about eight miles without finding any solid rock, and then struck north-north-eastward through a level country with a good clayey and gravelly loam soil. It is covered with brush, broken by ponds and prairie openings. We also passed through a strip of large timber, a mile and a half in width; the trees consisted of aspen and balsam, poplar, spruce and tamarac. With the exception of a few trees on the south side of the Assiniboine near Fort Pelly, spruce and tamarac were first observed on coming to Big Boggy Creek. Some of the tamaracs were upwards of a foot in diameter.

From the above point on Big Boggy Creek, I followed a straight north-north-westerly course back to the Crow Stand, the distance being about 26 miles. Most of our course lay several miles to the east of the Assiniboine River. In the above interval the soil is sandy, in some places light and poor, but generally mixed with loam and of a fertile character. Boulders were scarce, except near the Crow Stand. The surface of the country is slightly undulating. Rather more than half the area consists of prairie openings, the remainder being covered with poplars and willows. In the prairie portions the moles have thrown up almost every foot of the soil into little hummocks, often for miles at a time. Surface water was scarce when we passed over the ground in the beginning of August."

Speaking of the country along Swan River, about 12 miles from Fort Pelly, he says:—

"Immediately after crossing Swan River we entered the Five Mile Woods. The trees are mostly aspen and balsam poplar, with some spruce and white birch. In the woods the soil is an excellent clayey loam overlaid with black mould. Emerging from the Five Mile Woods, we entered upon the Square Plain, which has a length on the trail of about 16 miles. In the first or southern sixteen miles of this distance, prairie openings alternate with groves of aspens, and the soil is of a coarse sandy character, with some gneiss boulders. The remaining ten miles consist of prairie, with bushes in some places, and the trail passes over a fine loamy soil, the best we had seen since leaving the fertile prairie land of the Lower Assiniboine valley. The sandy soil in the southern part of the Square Plain is furrowed by old buffalo tracks running in the same direction as the trail. Thunder Hill lies on the western side of the Square Plain, and the brook named after the hill joins the Swan River near its eastern corner. Leaving the Square Plain, we passed through the Poplars, which have a length of about five miles on the trail, and after crossing a short interval of dry sandy land, entered upon the Great Meadows, which are said to extend all the way to "the Store" at the second crossing of the Swan River. In going through the Poplars the trail in the second or eastern half of the distance runs along the top of a ridge of shingle varying in height from four to twelve feet, but averaging from five to eight, and having a width of from one to three chains. It is composed mostly of pebbles of gneiss and grey limestone, and is flanked by a swamp on each side. The Great Meadows have a level, dreary appearance, and are overgrown with rank sedges, grasses and vetches, interspersed with clumps of willow bushes. They would yield an almost inexhaustible supply of excellent fodder for cattle and horses. The soil is a rich black loam, but apparently too wet for cultivation without drainage, which, however, could be easily effected, as the surface is 30 or 40 feet above the

level of Swan River. The remains of ancient beaver-dams are a noticeable feature in this area. Owing to the level nature of the ground, they have necessarily been built of a great length. They are now all dry, with the exception of a little water at the gap, which is opened through the lowest point in each of them. These old beaver-dams may be taken as one of the evidences of the greater abundance of water in this region in former times."

Mr. J. W. Spencer in describing Porcupine Mountain writes as follows :—" Porcupine Mountain forms a continuation of the chain of high ground which marks the eastern limit of the second of three great prairie steppes of the North-West Territory. It rises to the height of about 800 feet above Swan Lake. Between the base of the mountain and the lake is a belt of about twelve miles of low ground, consisting of open marshes, or " muskegs," tamarac swamps, &c., while the remainder of the interval is densely wooded with aspen, balsam, poplar, spruce and willow. On the slope of the mountain I saw balsam poplars six feet in diameter, while in some cases spruces reached a thickness of nearly four feet. This forest is more ancient looking and bears fewer evidences of fire than any other that came under my observation in the North-West Territory. The region is little frequented, even by Indians, being difficult of access. Although fire has not visited the slopes of the mountain, or the level ground below for a very great length of time, yet the whole of the forest on the summit was swept away a few years since, and in its place a young growth of poplars has sprung up."

After a careful examination of all the authorities in connection with the Second Prairie Steppe, I am quite safe in saying that at least two-thirds of the whole area was covered with forest at the beginning of this century, and that all this forest land was suitable for cultivation. Further, I am quite safe in coming to the conclusion that all this region can be again covered with forest by planting, fencing, and occupying the country so as to cause the extinction of the prairie fires.

Commencing at Pembina Mountain the escarpment forming the eastern boundary of the Second Prairie Steppe has an altitude of about 250 feet. From the point where it crosses the 49th parallel it sweeps to the north-west and assumes a more gentle slope, being broken up into three or four subsidiary terraces. It then meets the Assiniboine, near the mouth of the Souris, and passing by the hills east of Pine Creek attains a higher elevation and obtains the name of Riding Mountains, which, with other elevations having various names, extend to the Saskatchewan, near Fort a la Corne.

Numerous springs and swamps are found all along the face of the escarpment, increasing in size and volume to the north-west, where they merge into the swampy country east and north of Duck Mountain.

The Souris, the Q'Appelle, the Assiniboine, the Swan, the Red Deer and Carrot rivers all take their rise in the Second Prairie Steppe and drain the vast area included in it. The three former run in valleys from one to two miles wide and from 200 to 300 feet deep. All the small streams which convey the surface waters of the plains to the rivers cut deep narrow valleys in the plain, and cause the cartroads to cross the least watered part.

One feature of the Q'Appelle should not be passed over without mention. That is, the series of beautiful lakes near the upper part of its course, which are well stocked with fish, especially whitefish. This river seems to have discharged at some remote time a part of the water of the South Saskatchewan, as the source of the Q'Appelle is actually within twelve miles of the " Elbow," and the same valley extends to it. Its depth below the prairie level being no less than 140 feet.

The river valleys are all well stocked with wood, consisting chiefly of elm, ash, ash-leaved maple, balsam, poplar and willows, while the slopes which lead up to the prairie level above are generally covered with a thick growth of aspen poplar. Oak is common on some spots along the Assiniboine, but it seems to pass but a short distance into the Second Prairie Steppe. After leaving the river valleys, but little timber is left on the level country, the fires having been steadily encroaching on the forest area from time immemorial. The ranges of hills, however, are still more or less clothed, and these, owing to their greater rainfall and less exposure to fire, are

likely to retain their wood until the axe of the settler destroys what was once a vast and continuous forest. In the North-West and in the neighbourhood of Fort Pelly the greater rainfall, combined with imperfect drainage, causes the formation of swamps and the growth of black and white spruce, which will yield sufficient timber for the settlers for many years to come.

Wood Mountain, Turtle Mountain, Pleasant Mountain, File Mountain, Touchwood Hills and many other wooded hills rise at intervals throughout the plain, and show by their moist soil, their luxuriant vegetation and the springs oozing out of their flanks that much of the apparent want of water is not real, but is a consequence of the nakedness of the land.

The soil of the region is inclined to be sandy, but, with the exception of the triangular area enclosed between the Qu'Appelle and the Assiniboine, the eastern slope of the escarpment and the eastern face of the Little Touchwood Hills, I saw none but what would be called good land in Ontario. In fully one hundred places I saw the soil dug up, and, invariably, the surface was black loamy soil mixed with sand ranging from a few inches to over two feet in depth. Under this the usual subsoil was limestone gravel mixed with rich-looking marly earth in varying proportions. Soil of this description extends from the confines of Manitoba to nearly 100 miles north of Carleton on the road to Green Lake. In the valley of the South Saskatchewan and between it and Carleton the soil shows more signs of alluvium; there is more sand contained in it, and there are few if any pebbles in the subsoil. The bare isolated hills that are frequent in many parts are almost all gravel and are useless for agricultural purposes. Boulders are met with in profusion in many places, and very little of the region in question is without them; but still they do not form a very marked feature of the country except in the vicinity of "Mount Camel" or Round Hill, where for a few miles both east and west they are very abundant.

Little has been done in the way of agriculture, except at the Hudson's Bay Company's establishments, but all attempts which have been made, show that the soil is admirably adapted for the raising of all kinds of grain, especially wheat and peas. Over sixty families reside at Prince Albert Mission on the North Saskatchewan—forty-six miles below Carleton—and raise large quantities of wheat, besides other grain. Last year over 3,000 bushels of wheat were raised, and this year much more. A steam grist and saw mill was put up last winter, and by this time it is in successful operation. Everything is in a progressive state, and the colony has successfully demonstrated that thriving communities can be established in the far interior. On the banks of the South Saskatchewan, at the lower crossing, I found no less than fifteen settlers in October, 1875, where there was not the sign of a settlement in August, 1872. They had raised good crops the preceding year, and on my second visit had a large tract of land broken up. Sixty miles north of Carleton, on the Green Lake Road, a mission had been started by a Church of England Missionary named Hynes, in the fall of 1874. Last year he raised wheat, barley, peas and potatoes, the latter in abundance, and had bright anticipations for this year. He was a practical English farmer, and he said that the modicum of sand in the soil was an element of success in raising crops in the north, as the crops grew much quicker, and hence were less likely to be injured by frost.

The Third Prairie Steppe.

The boundaries of this "Steppe" on the east are the western bounds of the preceding section. These are the Missouri Coteau, or Thunder-Breeding Hills, on the boundary and south of the Saskatchewan, the Eagle Hills between the two Saskatchewans, and the Thickwood Hills north of the North Saskatchewan, and west of Fort Pitt. Speaking of the southern part of this section, Mr. G. Dawson writes: "The strip of broken country embraced under the name of Missouri Coteau, from where it comes to the boundary line, to the Elbow of the South Saskatchewan, has an area of about 7,500 square miles, of which the greater part must always remain unsuited for purposes of agriculture from its rugged and stony character. It would, however, be an

excellent stock-raising district. Though some of the steeper hills are but scantily clad with vegetation, a growth of good nutritious grass covers most of the surface, and swamps and sloughs with excellent hay grass are scattered everywhere. In its physical features, the Coteau resembles Turtle Mountain, and like that place, would no doubt naturally be covered with wood, but for the prairie fires, which sometimes run hundreds of miles in the dry weather of autumn. As it is, the want of wood is one of the most serious drawbacks, and animals fed over these hills in summer, would require to be wintered in some of the river valleys to the north, or in the wooded ravines of the Tertiary Plateau to the south. South and west of the Coteau lies the great plateau of the Lignite Tertiary, which may be said to begin about the 350 mile post, extending as a well-defined table land as far as White Mud River, a distance of 115 miles, in the vicinity of the line. Its form is very irregular, but its area may be about 12,000 square miles. The soil of this plateau appears as a rule to be of a fertile character, but the indications are that the rainfall, except in a few favoured spots, is too small for the growth of the ordinary crops. Its elevation also, no doubt, renders it more subject to early and late frosts than the prairie to the east, though the winter is probably not so long as that of the Valley of Red River. On reaching this part of the third plateau in June of 1874, the vegetation, from a comparison of the flowering plants, appeared to be about a week behind that of the Second Steppe. The plateau of the Tertiary is for the most part adapted only for pastoral purposes, but being covered with a good growth of grass is well suited for this use.

An important advantage of this plateau is the existence along its edges of sheltered ravines and valleys containing groves of poplar; and also the presence of great lignite deposits beneath it. In one of these sheltered valleys the half-breed settlement known as Wood Mountain is situated.

West of White Mud River to the 505th mile post an undulating prairie is passed over, resembling in its vegetation the surface of the Tertiary Plateau. It is deeply drift covered. Beyond this point an outlying portion of the Tertiary Plateau stretches for about 30 miles. It is much cut up by ravines, and in some places is very stony, but in general it is overlaid by a close sod, diversified by a few swamps covered with good grass.

Beyond this portion of the Tertiary Plateau an arid plain stretches with little interruption for fifty miles, nearly up to Milk River. It also extends far north-westwards towards the Cypress Hills, and appears to coalesce along their western front, with a similar desert region which—according to Palliser—exists to the north. It appears to be irremediably sterile and useless. In early spring, it is evidently in many places wet, but in summer, dry, hard and fissured, scarcely supporting a sod. It is traversed by the valleys of the East and West Forks of Milk River which rise in the vicinity of the Cypress Hills; but both the main streams and their tributary coulés become nearly dry before the end of summer.

The western limit of this plain, is formed by a strip of more elevated land lying between it and Milk River, about five miles wide. This is again based on the Lignite Tertiary formations, and shows a uniform short sod, a few lakes and swamps, surrounded with fine hay grass lying along its eastern border.

Westward from the Milk River, the unfertile Cretaceous clays do not recur, the country being based on the Lignite Tertiary. To the base of the East Butte, the surface, though not of the same desert character as that met with east of Milk River, is covered by a short, thin sod only, and is, besides, in many places, stony. The unfavourable appearance of all this region does not arise so much from a deficiency in the soil itself as from the absence of sufficient moisture. Vegetation, in fact, depends chiefly on the saturation of the ground by the water of the melting snow and spring rains; and when this supply is exhausted, its further growth is stopped as effectually as it would be by the incoming of winter.

The height and mass of the Sweet Grass Hills (Three Buttes,) of which the highest or western one is 6,483 feet above the sea, is such as to cause the formation of clouds, in their immediate vicinity, where the rainfall is, in consequence, much

more copious. These mountains, and the broken ground around them, form a favourite haunt for the buffalo, which here find abundance of food and water. The springs rising from some parts of the Buttes are very ample, and form extensive streams; these on leaving the shelter of the wooded valleys, and issuing on to the plains, are rapidly absorbed by the dry soil and atmosphere in the summer season. One of these was observed to be a rapidly flowing brook during the night and morning, but in the afternoon it became quite dry.

From the Sweet Grass Hills, toward the Rocky Mountains, the country improves in appearance, and shows evident signs of a greater rainfall. The Cactus, Greasewood and *Artemisia* disappear. To the Second Branch of Milk River---a distance of fifty-five miles---the country is generally much broken, but shows remains of a former more elevated surface, in somewhat extensive flat-topped hills, which when ascended, are found to be nearly of equal height, whilst the soil upon them is drier and more gravelly than is elsewhere found in this region. There is usually a close, thick growth of grass, and the swamps and sloughs, which are numerous, generally hold grasses and carices to the exclusion of the rushes formerly most abundant. The water-shed region, from the Second Branch of Milk River to the St. Mary's River, is of a similar character.

The portion of the fertile belt fringing the eastern side of the Rocky Mountains, in the neighbourhood of the forty-ninth parallel, is about twenty-five miles in width. On crossing the St. Mary's River, a very marked and rather sudden change for the better is observed. The surface at the same time, becomes more undulating and broken, and is quite hilly before the actual base of the mountains is reached. It is now covered with a thick vegetable soil, supporting a luxuriant growth of grass; and wherever the fire has spared them trees are found in all stages of growth. Many plants last seen in the neighbourhood of Pembina Mountain and Red River Valley, and which across the more arid plains have been lurking only in sheltered hollows and damp coulés, now reappear over the surface of the country generally. The rivers and streams, also, entirely change their character, and instead of flowing sluggishly with a milky opacity, now hold clear blue water, run swiftly over stony and gravelly beds, and are filled with trout."

The foregoing description will show that the character of the Third Prairie Steppe is much more varied than that of either of the others; but also that no part of its southern extent compares favourably with the land of the Red River valley, or that of the best parts of the Second Steppe—always excepting the land along the base of the mountains. At the same time, the Boundary Survey has served to show, that this country formerly considered almost absolutely desert, is not—with the exception of a limited area—of this character; that a part of it may be of importance agriculturally, and that a great area is well suited for pastoral purposes and stock farming.

This fertile belt to the north, must form the basis for the settlement and utilization of the western plains. The cactus-covered desert tract does not seem to stretch far to the north of the line, but there is an extensive region of the Third Prairie Steppe, south of the fertile belt, which is described as having a poor soil, with scanty herbage, and no wood, except on northern exposures.

Captain Crozier, who has been in this region for three years, thus writes to a friend in this town, his letter bearing date Nov. 8th, 1876. He writes from Fort Calgary:—

"The fort is situated at the junction of Bow and Elbow Rivers, on a beautiful flat (or, as they say here, "bottom,") as level as a cricket ground, and of immense extent. We are in the midst of the buffalo, and the rivers are filled with fine mountain trout. I have been fishing several times lately, and really enjoyed the sport very much. A Canadian, who has been in the habit of catching what we used call speckled trout, can scarcely fancy trout being the size that these fish are here.

"The country appears much finer about here than that at Fort Macleod, if one can judge from the appearance of the soil and the fine grass. When I came here in the early autumn, the whole country looked like a magnificent meadow. I am told,

though, that there are very heavy summer frosts, something, I think, that is hardly known about Fort Macleod, which place, in my opinion, so far as the climate is concerned, is the finest part of the North-West.

"The winters at Fort Macleod are undoubtedly very much milder than in Manitoba or even on the Saskatchewan, and, unless during occasional severe storms, cattle and horses will thrive and live out all winter. We have here a warm, south-western wind, called the 'Chinook,' which makes a great difference in the climate. I have known the weather to be intensely cold, and in a few minutes—owing to the wind—the air would be as warm as in summer.

"Although this country—the south-western part of the North-West Territory—is not equal to the Saskatchewan country for farming, *i.e.*, the raising of grain, I have no doubt that in time it will be a great stock-raising country, and if those men who went into that business in Montana can be taken as an example, it requires but little capital to make a commencement by which a man may soon become independent.

"The cold was for this season of the year severe last week—so much so that the rivers were completely frozen over, and they are very rapid streams; but the last three days have been quite warm, the ice is completely gone, and the weather is like early summer. We are taking advantage of the fine weather and getting everything ready for the winter; the men, a splendid lot of fellows, are working away like Trojans."

Verbal reports from various parties indicate that there are many tracts of first-class agricultural lands south of the North Saskatchewan. The valley of Battle River is very highly spoken of as well as the valleys of Bow and Belly Rivers. The Rev. W. Macdougall told me that the Blackfeet country was the garden of the North-West and later reports tend to confirm this statement. I think from the detailed account given above of the character of the country along the line where it is the highest and driest, an unprejudiced person will be prepared to believe the testimony of all who have been in the country that it is one which will be valuable both for pastoral and agricultural purposes.

Not having seen the district referred to myself I cannot speak from personal knowledge of any part of it except that north of the North Saskatchewan. After passing the North Saskatchewan the country has a moister climate, the soil seems to have more humus, and there is every indication that at no remote period the forest reached to the river.

I have no data at command to show the extent of prairie country north of the Saskatchewan and east of Carleton, but having traversed the area from Green Lake to Carleton I know that the continuous forest is not reached until the traveller passes at least 70 miles north of the latter place. The Thickwood country may be said to follow the watershed between the Beaver and the Saskatchewan Rivers to the head of the former river, approaching nearest to the Saskatchewan a short distance east of Victoria. Passing on, the line touches Lac La Nun and Lake St. Anne, and bending more to the south, reaches the base of the Rocky Mountains on the Brazeau River.

The rainfall throughout this whole region is abundant, and the vegetation most luxuriant. Although the land slopes towards the river, the inclination is not very great, but is sufficient to drain the land and cause the sun's rays to strike more vertically and hence with more heating power on the soil. North of the Saskatchewan the country changes frequently, and at times is rough and hilly, but taken as a whole it is much superior to the district south of that river. Wood, water, pasture and meadow lands are in abundance, the lakes and rivers teem with fish and the soil produces enormously; there is, however, one drawback. Owing to the abundant rainfall and little evaporation, there is much moist or swampy land and this so lowers the temperature at times that summer frosts are of frequent occurrence between Fort Pitt and Victoria. When the land is cleared, and these marshes are drained, summer frosts will cease, and this region will be second to none in the North-West.

Fort Pitt being on the borders of the Buffalo country, has no cultivated fields

around it, but at Victoria Mission (W.M.) and Lac la Biche (R. C. Mission) the Indians and half-breeds raise an abundance of wheat and other cereals, together with enormous crops of potatoes and garden vegetables. At Edmonton and about its vicinity, large fields are cultivated, and at St. Albert, nine miles from it, there is a large half-breed settlement and much land under the plough.

Athabasca and English River Districts.

From Cumberland House on the Saskatchewan to Lake Athabasca, the Hudson Bay Company's route seems to follow the separating line between the Laurentian rocks and the limestones of the Silurian, and this line may be said to separate the fertile lands from those that are unsuitable for purposes of agriculture. This route follows a chain of lakes to Frog Portage, and from thence by English River (Churchill) to Isle La Crosse Lake—from thence by Buffalo and Methy Lakes to Portage La Loche, and thence down the Clearwater and Athabasca rivers to the Lake. A line drawn from Lake Athabasca to the west end of Little Slave Lake, and from thence to near Jasper House at the base of the Rocky Mountains, will be the one side of a triangle, the opposite side being a line from Jasper House to Lake St. Anne, and thence along the watershed between the Saskatchewan and Beaver or English river to Cumberland House. This large triangular area may be described as a land of rivers, lakes, marshes and swamps, with many large tracts of first-class land, even at present; whilst immense areas will be brought under cultivation when the forest is removed.

At various points of this section, I found crops growing, and in every case there were large returns received from the soil. Sir John Richardson says that wheat is successfully raised at Cumberland House. At Lac La Biche, at the head of Beaver River, the missionaries raise excellent crops of wheat and other cereals.

At Little Slave Lake in 1872, I found barley in stack, which had been cut on the 12th August, while that at Edmonton, on the Saskatchewan, was not cut until the 26th of the same month. I was at Isle La Crosse on the 22nd September, 1875, and saw potatoes still as green as they were in July. I was told by Mr. Cummings that their potatoes are hardly ever killed by frost in September. Here there was a flour mill driven by horse power, and all kinds of grain are reported as ripening successfully. On the borders of Clearwater, Buffalo and Methy lakes, I saw numerous potato fields cultivated by Chipweyan Indians, who lived altogether on fish and potatoes. I was at the forks of the Athabasca and Clearwater Rivers on the 8th September, 1875, and found tomatoes, cucumbers, wheat and barley under cultivation together with all the vegetables found in kitchen gardens in Ontario. Here was a fine tract of prairie, which the Hudson Bay Company were going to cultivate, and from which they intend, in the future, to supply the whole north. On the night of the 8th occurred the first frost which had been known on the Lower Peace and Athabasca Rivers since early in May. All the cucumbers were killed at that time, but no frost occurred at Isle La Crosse. I spent ten days at Athabasca, and obtained specimens of wheat and barley, which have astonished all parties to whom I exhibited them. Many of the ears contained one hundred grains, and the weight of both wheat and barley was nearly ten pounds above the ordinary weight per bushel. These grains had been raised on soil comparatively poor—very poor for the district—and lying only a few feet above the level of Lake Athabasca.

The timber of this whole region consists of but very few species, as follows, (they are enumerated according to their abundance)—aspen poplar, black and white spruce, Banksian pine, black pine (*Pinus contorta*), white birch tamarac and balsam poplar. The good dry arable land is either prairie or aspen forest, and this tree is always found on the dry sunny slopes throughout the district, and in fact all over the North-West. On the watersheds and at higher elevations, an intermixed forest of black and white spruce and aspen is found, and here the trees attain a large size; the former being well suited for lumber and other purposes. In the river valleys, the balsam poplar takes the place of the aspen, and white spruce attains its greatest dimensions. The swamps

are chiefly covered with black spruce of small size interspersed with occasional tamarac; or they are altogether devoid of trees, and covered with varied species of *Sphagnum* (peat moss) and Ericaceous shrubs; in this case they are called "muskegs." On the Lower Athabasca and around the various lakes, white birch is found in abundance, and from its sap a very palatable syrup is made in the spring by the Indians and half-breeds. The sandy and barren lands of the district are covered with a thin growth of Banksian pine north and east of Little Slave Lake, whilst to the south and west, *Pinus contorta*—a closely related species—takes its place. The lands covered with these trees are nearly all unfit for occupation, owing to the sandy nature of the soil. Much of the land in the vicinity of Methy and Buffalo Lakes is covered with the former species, and may, therefore, be set down as very poor and sandy. In the mountain swamps only I observed balsam spruce (*Abies balsamea*), and even then it was of rare occurrence. I never saw an elm, ash, maple, pine, (other than those spoken of above), oak or cedar west or north of the Saskatchewan or on Peace River, and I am quite certain none exist.

The whole country around the south and west of Lake Athabasca is a vast alluvial plain, elevated but a very few feet above the lake level, and in some years much of it remains permanently covered with water. The first night after leaving Fort Chipweyan we slept in the boat on account of the lowness of the land which was not more than a foot above the level of the water. The Athabasca has formed a large delta at its mouth, and is every year silting up the lake with its muddy water. For miles before we entered it from the lake, we passed over mud flats due to the same cause. The mouths of the river are merely a series of willow swamps and islands scarcely a foot above the present (Sep. 3rd) level of the water. I am unable to state the breadth of the main channel of the river, as it was quite evident that we entered by one of its smaller discharges.

Where we breakfasted, the land had risen to a height of two feet above the water—at dinner, four feet; and where we slept, six feet above it. This was 25 miles from the Lake and the first spruce was seen, showing that the land was only subjected to flood in the spring.

One day and half from the lake we reached the "River Embaras." where the delta commences. At this point the general level is about ten feet above the water. The whole of the country between this and the lake is alluvium brought down by the river in bygone ages. All this immense delta, including Lakes Clair and Mamawa and their bordering marshes and all that part of the Peace River valley below Peace Point may be called a delta or *the* Delta of the Peace and Athabasca rivers. There is no doubt in my mind but that, at one time, all this region was lake, and that it is now silted up or being silted up by those rivers. The deposits of the Athabasca have encroached so much on the lake that there is not more than six miles from Fort Chipweyan to the line of willows which marks the division between mud and water. Outside of the willows there are more than two miles of mud shoals covered with a thick growth of *Potamogeton* (River Weed), and a gradually diminishing depth of water as one approaches them. The water of the Athabasca is even muddier than that of the Peace, but that which issues from the lake is quite clear. In fact, the delta of Lake Athabaska is almost a Manitoba in embryo, as it is now what the latter once was.

From the "Delta" the country rises very gradually all the way up the Athabasca and eventually passes into the foot-hills of the Rocky Mountains on one side and the watershed of the English River on the other. The whole is a gently sloping plain with the Birch Mountain breaking the general level south of Lake Athabasca, and the Deer Mountains south of Little Slave Lake.

All the lakes and rivers of the district teem with fish of a large size and excellent flavour. Whitefish swarm in myriads in Lake Athabasca, Little Slave Lake, and all the lakes and rivers discharging into English or Churchhill river. Four-fifths of the food of the Chipweyan Indians consists of this fish, while their dogs and those of the Hudson's Bay Company devour multitudes of them. Suckers and pike (jack fish) are frequently taken, the former being always turned over to the dogs or dried

for their winter food. Many of the lakes are covered with a green confervoid growth which seems to be the chief food of the whitefish. Green Lake, Isle La Crosse Lake, Buffalo Lake and Clear Lake are most noted for this growth.

In passing from the Saskatchewan to the valley of Beaver River or the Athabasca, the traveller would hardly notice the change of level except by the flow of water, with the greater moistness of the soil, and the increased number of lakes. The upper part of the district (south-west) is much wetter than that east and north of Little Slave Lake and the line contemplated for the Pacific Railway, from Lake St. Anne to Jasper House, seems to pass through about the worst part of it. This region of muskeg and swamp is probably caused by the deposition of moisture occasioned by the cooling influence of the glaciers toward the head of the Athabasca and Saskatchewan.

Peace River and Mackenzie River District.

Not many miles north-west of Jasper House the aspect of the mountains changes, the southern slopes lose their wood and become clothed with grass instead of spruce forest--the plain, instead of being a continuous forest, changes its characteristics to those of park and meadow lands; on the line of approach to Smoky River, and between that river and the Peace in the longitude of Dunvegan and St. John's there is a further change to almost continuous prairie. The country when wooded is mostly covered with aspen, and the slight elevations which form the watersheds of the streams that flow into the Peace are generally crowned with spruce. North of Smoky river, on the right bank of the Peace the country soon loses its prairie character and becomes almost wholly an aspen forest which continues down to the delta of the Athabasca and Peace River. On the left bank of the Peace the prairie character of the country continues all the way to the vicinity of the 61° parallel, or to Fort Laird, but the aspen continues beyond the Arctic Circle. On the left bank of the Peace the country fit for raising cereals extends from Hudson's Hope, lat. 56° 12′ north, long 122° west, where it leaves the mountains, to the Arctic Circle in long. 141° west. Slave River—the discharge of Lake Athabasca—the south side of Great Slave Lake and the Mackenzie form the eastern boundary of this area.

The altitude of the district known as the "Peace River Country" is much lower than the Saskatchewan country, not being as elevated in latitude 56°, close to the Rocky Mountains, as at Edmonton, in latitude 53° 32′, which is 2,088 feet above the sea. Dunvegan, on Peace River, is only about 1,000 feet above the sea, and the general level of the adjacent country about 1,600. Lake Athabaska is said to be less than 600 feet above the sea, and as we proceed north the country gets gradually lower, until at Fort Norman, lat. 65°, we are nearly at the sea level. An examination of the map will show that all the rivers north of Peace River flow in a north-easterly direction towards Great Slave Lake. The change in altitude seems to keep pace with the increase of latitude as far north as Fort Laird, in lat. 61°, and the summer temperature of the latter is said to be just as high as the country along Smoky River, and in the neighbourhood of Dunvegan. At Vermillion, on the Lower Peace, in lat. 58° 24′, I found the temperature much higher than at Dunvegan, in lat. 56° 08′, so that I can easily believe in the above statement.

The whole country between the mountains and Athabasca and Great Slave Lakes is a gently sloping plain, being under 2,500 feet, in lat. 55°, and at the mouth of the Laird less than 400 feet, having become lowered to the extent of at least 2,000 feet in five degrees of latitude, or six feet to the mile. Ranges of low hills cross it at intervals, but nothing like a mountain is seen, except the Buffalo Hills, south of Vermillion, and the Cariboo Mountains, which seem to be 40 miles to the north-west of it. These ranges may only be a few hundred feet in height, and are possibly the continuation of the plains of the Upper Peace. They serve as watersheds to separate the valley of the Peace River from that of the Hay River on the north, and that of the Loon River on the south.

The whole country seen or heard of throughout the region in question is covered with a deep, rich soil, of wonderful fertility, free from boulders, and having very few swamps or marshes. The rainfall seems to be less than that of Ontario, but this is compensated by copious dews, which keep the grass and herbs growing all summer. The clear skies and long summer days, combined with the lowering of the temperature at night, seem to give astonishing vigour to vegetable growth, and to cause grain and seeds of all kinds to be far more prolific here than further south.

The following extracts, taken from my former report (Pacific Railway Survey 1872), will show the character of the country under consideration. Speaking of the country between Little Slave Lake and the mouth of Smoky River, I write as follows:—

"From the Post at the west end of Little Slave Lake, a number of bare hills could be seen, rising from the margin of the lake at its northern corner. These I took to be barren, but what was my astonishment to find that they were actually covered with prairie plants. I found afterwards that this was no uncommon occurrence, but that *in all cases*, up to the base of the mountains, hillsides or river banks with a south-western aspect, were devoid of trees, and clothed with a flora having a more southern tendency than the latitude would warrant. Two causes produced this—inclination to the sun and a scarcity of moisture, caused by the constant evaporation during the long summer days. In opposition to this, all slopes and river banks having a north-eastern slope, were covered with a thick carpet of moss and coniferous trees. Peace River and *all* its tributaries are of this character.

For many miles, the path leads through aspen woods, with the usual forest flowers; but no decided change takes place until we reach the height of land between Peace River and Slave Lake. Here a number of species show themselves that had been seen in the muskegs east of Deer Mountain. The only ones worth remarking are the Arctic Raspberry (*Rubvs arcticus*), Cloud Berry (*Rubus Chamœmorus*), and the Black Crowberry (*Empetrum nigrum*) Although it is a summit, there is no sign of a hill, but merely level moorland covered with willows and Dwarf Birch (*Betula pumilla*), with a muskeg or two to vary the monotony. Copse and grassy glades, interspersed with marshy spots, soon took the place of these, eventually to pass into a level plain that extends for many miles." In my journal, I entered the following:—"The last eight miles have exceeded anything in beauty and fertility I have seen since leaving Edmonton. Far as the eye could reach," (we were travelling at this time through a prairie,) "and on the left, the view extended for many miles; aspen copse interspersed with willows met the eye. We were passing along a creek, and the land rose with a very gentle slope on either hand, giving us an opportunity of seeing for a great distance. This prairie had, at one time, been covered with trees, as the blackened trunks scattered over the ground plainly shewed." No change took place after this until we reached Peace River, where I detected many species peculiar to river bottoms, but none worth a special notice. On the grassy slopes leading down to the river, I found the Three-flowered Geum (*Geum triflorum*), the Pasque Flower (*Anemone patens*) and an Oxytropis (*Oxytropis splendens*) in full flower. Evidently a long spell of dry weather had been followed by rains and warm weather, to cause spring flowers to be in beautiful bloom in October.

Mr. Horetsky rode over the portage, between Smoky River and Dunvegan, a distance of at least forty miles, and he told me it was beautiful prairie all the way. This was on the north, or left bank of the river. As I proceeded up the river I could see that the left bank was a constant succession of grassy slopes, with aspen copse and service berry thickets in the hollows. The right bank on the other hand was always wooded, the timber being aspen, white birch, and spruce. The islands and points that formed the secondary bank of the river were generally covered with balsam poplar of a large size, but spruce, aspen, and birch were in considerable quantities. Long-leaved willow (*Salix longifolia*) first took possession of the recently formed mud banks, quickly followed by balsam poplar, which, on the same island, could be seen passing from a seedling of a year old up to the hoary monarch over six feet in diameter. As the islands get old, poplar gives place to spruce, and this holds

good for the whole extent of the river. Spruce was never observed on new islands, but always on the old ones. The same order of succession takes place on the Lower Fraser.

Mr. Horetsky and myself travelled overland from Dunvegan to Fort St. Johns, a distance of 115 miles, and the following remarks refer to this region :—

"Between Dunvegan and St. Johns, a distance of about 120 miles by land, the trail passes through many miles of beautiful farming country, alternating with spruce, aspen 'cypre' woods on the divides between the various streams which flow into the Peace River."

The following extract was written the day after I left Dunvegan :—

"For six miles after leaving camp the country remained the same as yesterday. It was gently rolling, yet not a height or depression was equal to ten feet. Drainage perfect. Every hollow was connected with others, and hence there was no marsh. The country was almost denuded of trees, probably by fires, and had much the appearance of prairie without its uniformity. After this, the country assumed a park-like character—was almost a dead level and more than half covered with trees. These eight or ten miles for beauty and fertility surpass anything we have yet seen."

The country in the vicinity of St. Johns, on the left bank, is thus referred to in my report of last year to Mr. Selwyn :—

"Mr. Selwyn having decided to build a canoe for the ascent of Pine River, I had a number of days to look around, and on the morning of the 27th, accompanied by Anderson, I started up the hill in rear of the Fort for the purpose of examining the country north of the river. We found it to be 746 feet high, so that the level of the country above the river valley was over 700 feet. After the level of the plateau was reached, the country was either a dead level or sloped away from the river. For nine miles of the distance travelled the whole country was covered with the most luxuriant vegetation. Clumps of willows and poplars of various ages were interspersed with the most astonishing growths of herbaceous plants I ever saw, willow herb, cow parsnip, *Geum Strictum*, *Triticum*, *Bromus*, *Poa*, and a number of other tall-growing species covered the whole region with a thick mass of vegetation, that averaged from three to five feet in height. *Delphinum Elatum* (wild larkspur) was found over seven feet high and many vetches were even taller. In many places the peas and vetches were in such abundance as to completely cover up all other plants, causing the country to look like a field of mixed peas and vetches. The species were *Vicia Americana*, *Lathyrus Venosus* and *ochroleucus*, but the former prevailed.

It would be folly to attempt to depict the appearance of the country, as it was so utterly beyond what I ever saw before that I dare hardly make use of truthful words to pourtray it. Mr. Selwyn, who made an excursion ten miles to the north-west, reports a very luxuriant vegetation where he was—much greater than he ever saw at Edmonton or anywhere in the Saskatchewan country. Rainy River and the Little Slave Lake marshes are the only regions known to me that are in any way comparable to it. The latter, however, is marsh, and this is a plateau nearly level, and over 700 feet above the river.

The soil must be exceedingly rich to support such a growth year after year, and the early summer temperature must be high to have vegetation so far advanced at this period (July 27th.) All the cultivation done at St. Johns is on the terrace immediately above the spring floods on both sides of the river, but there is no reason why cereals should fail on the top of the hill, as, if anything, the soil is better. There was only about a week between the ripening of the berries on the hill top and those near the river, yet the difference in altitude was about 700 feet. "Nigger Dan" told me that the snow was only about a week later going off above in spring.

The face of the hills on the left bank, where not too steep, is very warm, being inclined towards the sun at a considerable angle; and it is here where the greater part of the prairie flowers are met with. The *Opuntia*, a species of Cactus, is found here, in company with many prairie species. On these slopes, Capt. Butler saw *Anemone patens*, or Pasque flower—the first flower which shows itself in Manitoba,—covering the ground with its pale blue flowers, as early as the 22nd of April, 1873; and the

preceding October, as late as the 27th, I saw *Erigeron* and *Aster* still in flower. The whole of my observations tend to show that, leaving out the flora of the slopes on the left bank, almost all are identical with those of Ontario. I spent over a week in the vicinity, and had ample opportunity for examining the conntry on all sides."

Of the country in the neighbourhood of Vermillion, lat. 58° 24', I wrote as follows:

"The whole country around this fort is a level plain, not being elevated at its highest point more than 100 feet above the river, but the greater portion of it is less than fifty feet. I made frequent enquiries about its character, at a distance from the river, and all agreed in saying that it was exactly like that which I saw there.

From the highest point reached, I could look across the river and see the Cariboo Mountains, which appeared to be some forty miles off. Between the spot where I stood and these mountains, the country seemed to be perfectly level, or else to slope gradually upwards towards them. As far as the eye could reach, the greater part of the country was covered with a continuous aspen forest. Here and there a group of spruce was seen, indicating a low or marshy spot. But from the prevalence of the aspen, the country may be said to be covered with an aspen forest on both sides of the river. Cold nights were common on the upper part of the river; but here, where the banks are low, the days and nights are *both* warm, and summer frosts are almost unknown. The frost spoken of in the former part of this report, which occurred on the 28th June, extended from McLeod's Lake, to Dunvegan, but was not noted lower down. No frosts had occurred here since early in May, and none were expected until next month (September.) Often a whole season will pass without a frost occurring from early in May until late in October; but when winter does come, it is continuous.

The soil examined was of the very best description, being evidently alluvium, but of what depth, I had no means of determining. On the immediate bank of the river, the subsoil was a "till," composed of gravel and clay, which was often of a reddish colour. It was from this colour that the Fort got the name "Vermillion." About half a mile from the river, the land took a rise of nearly fifty feet, and with the rise, the luxuriance of the vegetation increased. Much of the country had been burnt over, and the timber was either all gone, or in various stages of decay."

Of Little Red River and the Peace River below I wrote as follows : "I occupied myself all the 16th collecting fossils and making a botanical examination. I found that Red River was even warmer than Vermillion, and that all vegetables were much more advanced. When St. Cyr, who had charge of the Fort knew I was a botanist he invited me to look at a strange plant he had in his garden. What was my astonishment to find a bed of cucumbers with a number ripe on the vines and many green ones. I asked him if he raised the young plants in a hot-bed, but he knew nothing of such things. He told me he had no plough and could only cultivate a small patch, but that all kinds of grain would succeed admirably if the ground was cultivated. His beans (both Windsor and pole) peas, cabbage, turnips, potatoes and cucumbers were excellent. Summer frosts *never* do any harm here, and the soil is of first-class quality. At Vermillion I noticed that the country was beginning to show signs of being parched, and here the effects were such that the grass was beginning to dry up. I learned afterwards that rain had been deficient in quantity throughout the whole Peace River country this season.

Between Little Red River and Rapid Bouille the river is very wide, and seldom or ever confined in one channel. Mud or sand bars covered with willows and wide mud flats almost on a level with the water were of constant occurrence. These and islands in every stage of development or decay were the chief characteristics of the river bed, while the country along the banks seemed to be a low alluvial plain with a soil of surpassing richness. All the islands were covered with immense poplars (*Populus balsamifera*) while the aspen constitutes the greater part of the general forest on the mainland.

The climate of this section is so very different from that of countries farther east, that were I depending altogether on my own evidence I should be backward in

stating the whole truth. I was on the Peace River during the whole month of October, 1872, and the constant record was "Warm sunshine, west wind, balmy atmosphere, and skies of the brightest blue." Even as late as the 15th October, the thermometer was 48° at daylight and 61° in the shade at noon. Within the foot hills of the Rocky Mountains I picked up three species of plants in flower as late as the 26th of the same month. These facts and the testimony of all the residents in the country show conclusively that there is an open Fall all along Peace River from the Mountains to Lake Athabasca.

While at St. Johns last year, I looked over the journal kept by the Hudson Bay Company's clerk, and the average day on which the first ice ran in the river for 10 years was November 6th. The year I passed through the country it was first seen on the 8th, and in the year 1792, when Sir Alexander Mackenzie passed the winter at the mouth of Smoky River, November 7th. These dates show that the setting in of winter and the end of the ploughing season is at least eight days later than at Winnipeg. From the H. B. C. records I likewise found that winter set in at Lake Athabasca about the 25th October, or ten days earlier than at St. Johns. From my personal knowledge of the climate and the botany of the whole region from Winnipeg to the Rocky Mountains, and north to Lake Athabasca, I am quite safe in taking the first of November as the average commencement of winter over an area of nearly 500,000 square miles.

Captain Butler in his "Wild North Land" speaks of the whole hill-side at St. Johns being blue with anemones (*Anemone patens*) as early as April 22nd, 1873; and Sir Alexander Mackenzie records in his journal that anemones were in flower on the 20th April, 1793. From the Hudson Bay Company's journal I found that the average opening of the river in 10 years at St. Johns was on the 20th April. The year Captain Butler was there (1873) it opened on the 23rd, and the year Sir Alexander Mackenzie was on it on the 25th. These dates show that the spring is just as regular as the fall, and that the beginning of winter and the opening of spring are unvarying. At St. Johns, grain is sown and potatoes are planted from the 20th April, but at Vermillion and farther down, little is done until after the first of May. At Fort Chipweyan scarcely anything is done until after the 10th May, and often barley is sown after the first of June, and comes to maturity.

The period necessary for barley to mature is about 90 days, and for wheat not much over 100. "Nigger Dan" (Daniel Williams) had oats, barley, and potatoes growing at St. Johns when I was there. The latter he dug on the 2nd August, and they were large and dry; the two former were fit to cut about the 12th of the same month.

At Battle River, over 300 miles farther down, Indian corn has ripened three years in succession, and my observations show that the summer temperature at this point is greater than it is higher up.

At Vermillion, lat. 58° 24', I had a long conversation with old Mr. Shaw, who had had charge of this Fort for sixteen years. He says that frosts never injure anything on this part of the river, and every kind of garden stuff can be grown. Barley sown on the 8th May was cut 6th August, and was the finest I ever saw. Many ears were as long as my hand, and the whole crop was thick and stout. In my opinion that is the finest tract of country on the river. The general level of the country is less than 100 feet above it.

At Little Red River I found everything in a very forward state. Cucumbers started in the open air were fully ripe, Windsor and pole beans and peas were likewise ripe, August 15th. Fort Chipweyan, at the entrance to Lake Athabasca has comparatively poor soil in its vicinity, being largely composed of sand; still, here I obtained fine samples of wheat and barley—the former weighing sixty-eight pounds to the bushel, and the latter fifty-eight pounds. The land here is very low and swampy, being but little elevated above the lake. At the French Mission, two miles above the Fort, oats, wheat and barley were all cut by the 26th August. Crop rather light on the ground.

Mr. Hardisty, chief factor in charge of Fort Simpson, in lat. 61° N.,

informed me that barley always ripened there, and that wheat was sure four times out of five. Melons, if started under glass, ripen well, frost seldom does them much damage.

Chief trader Macdougall, says, that Fort Laird, in lat. 61° N., has the warmest summer temperature in the whole region, and all kinds of grain and garden stuff always come to maturity. He has been on the Youcan for twelve years and says that most years barley ripens under the Arctic Circle in lon. 143° W.

The localities mentioned were not chosen for their good soil, but for the facilities which they afford for carrying on the fur trade, or for mission purposes. Five-sixths of all the land in the Peace River section is just as good as the points cited, and will produce as good crops in the future. The reason so little is cultivated is owing to the fact that the inhabitants—Whites and Indians, are *flesh eaters*. Mr. Macfarlane, chief factor in charge of the Athabasca District, told me that just as much meat is eaten by the Indians when they receive flour and potatoes as when without them.

At the Forks of Athabasca, Mr. Moberly, the factor in charge, has cut an immense quantity of hay, as the Hudson's Bay Company winter all the oxen and horses used on Methy Portage at this point He told me that in a year or two the Company proposed supplying the whole interior from this locality with *food*, as the deer were getting scarce and supplies rather precarious. This is the identical spot where Mr. Pond had a garden filled with European vegetables when Sir Alexander Mackenzie visited it in 1787.

The following extracts are from Sir Alexander Mackenzie's travels. He passed the winter of 1792 and 1793 near Smoky River, and writes as follows: "November 7th, the river began to run with ice yesterday, which we call the last of navigation. On the 22nd the river was frozen across, and remained so until the last of April." Between the 16th November and the 2nd December, when he broke his thermometer the range at 8.30 a.m., was from 27° above to 16° below zero; at noon the range was from 29° above to 4° below, and at 6 p.m. it was from 28° above to 7° below. "On the 5th January, in the morning, the weather was calm, clear and cold, the wind blew from the south-west, and in the afternoon it was thawing. I had already observed at the Athabasca that this wind never failed to bring us clear mild weather, whereas when it blew from the opposite quarter it produced snow. Here it is much more perceptible, for if it blows hard from the south-west for four hours a thaw is the consequence. To this cause may be attributed the scarcity of snow in this part of the world. At the end of January very little snow was on the ground, but about this time the cold became very severe, and remained so to the 16th of March, when the weather became mild, and by the 5th of April all the snow was gone. On the 20th the gnats and musquitoes came, and Mr. Mackay brought me a bunch of flowers of a pink colour and a yellow button (*Anemone patens*) encircled with six leaves of a light purple. On the other side of the river, which was still covered with ice, the plains were delightful, the trees were budding and many plants were in blossom. The change in the appearance of the face of nature was as sudden as it was pleasing, for but a few days had passed away since the ground was covered with snow. On the 25th the river was cleared of ice."

While on Peace river, last year, I had instructions from Mr. Selwyn to observe carefully the flora of the country, for the purpose of comparing it with other and better known parts of the Dominion. With this end in view, I enumerated all the species found growing at the following six distinct points: Hudson's Hope, just east of the mountains; St. Johns, 60 miles below; Dunvegan, 120 miles further down; Vermillion, about 300 miles lower down; then Little Red River, 100 miles further down, and lastly at Lake Athabasca. As will be seen, the flora of the whole river is much like that of Central Ontario, and of the prairie region. It may be as well to remark that we can only deduce the temperature of the growing season from the character of the vegetable productions found. The following table gives the result of the botanical examination in a very condensed form;

	Total.	Belleville.	Quebec.	West of Mountain.	Western Plains.
Hudson's Hope	211	136	7	17	51
St. Johns	248	161	3	6	78
Dunvegan	246	160	2	5	79
Vermillion	159	112	2	1	44
Little Red River	128	88	1	0	39
Lake Athabasca	245	186	7	2	50

The only plants that show any signs of a boreal climate are those from Quebec. The two at Vermillion were Yellow rattle (*Rhinanthus cristagalli*) and High Bush Cranberry (*Ciburnum pauciflorum*). The most prominent feature in the whole region was a richness in the soil and rankness of vegetation never seen in Ontario.

The following data, selected principally from last year's meteorological report, will show the reason of the remarkable similarity between the flora of Ontario and that of Peace River. It is worthy of note that Halifax on the sea coast is nearly as cold in summer and autumn as Cumberland House *nine* degrees further north. I take the temperature of the three warm seasons and also that of the two *ripening months* July and August.

	Lat. N.	Summer.	Spring.	Autumn.	July and August.
Cumberland House	53·37	62·62	33·04	32·70	64·25
Fort Simpson	61·50	59·18	26·66	27·34	62·31
Fort Chipweyan	58·42	58·70	22·76	31·89	60·60
Winnipeg	49·53	60·30	46·50	17·10	64·60
Fort William	48·24	59·94	39·67	37·80	60·52
Toronto	43·39	62·40	49·90	34·00	68·50
Belleville	44·10	64·30	52·40	32·70	68·30
Ottawa	45·25	64·00	51·60	26·20	68·50
Montreal	45·31	63·90	51·10	27·60	68·25
Quebec	46·48	61·40	47·70	26·40	66·10
Halifax	44·39	60·00	46·20	34·30	63·70
York Factory	57·00	49·40	28·70	2·90	52·85

In conclusion, a few general remarks on the whole prairie region may not be out of place. In the United States, west of the 100th meridian, the character of the country is generally that of an arid, treeless plain, rising to the height of at least 7,000 feet in Wyoming Territory. The western section of Dacotah, and the greater part of Montana, are of this nature. As we pass north to the 49th parallel, the country loses its elevated character, the rainfall increases, the cactus and sage brush cease to grow at the Elbow of the South Saskatchewan; the surface becomes covered with grass and copse wood, which on the north side of the Saskatchewan are replaced by an aspen forest, and this on the watershed changes into one of spruce. No appreciable alteration in temperature takes place. There is only an increase of moisture as we pass to the north, and with this increase of humidity, a more equable temperature is noticed. Less radiation takes place as we leave the high treeless plains, and consequently the variation of temperature between day and night is less strongly marked.

None of the prairie country, except that south of the Missouri Coteau, is naturally so deficient in rainfall as to prevent forest growth, and as settlements increase the rainfall will become more abundant. All the old settlers in whatever part of the country they may be, assert that in the neighbourhood of the woods more rain falls than on the open plains,and these statements are borne out by all writers on the subject. Extend the area of forest land, and the rainfall will increase. It is to be doubted, however, that any deficiency exists. Manitoba is certainly as much prairie as one-half or two-thirds of the great region in the interior, and last summer the inhabitants complained of too much rain. So far as my own experience and information go, the Red River country in no way suffers from the want of rain, but

on the contrary is possessed of extensive marshes, swamps and forests, the product of a rainfall, which, in comparison with the evaporation, is even too abundant.

Captain Palisser, when in the Saskatchewan country in 1858–59, had pits sunk in the soil to see what depth the frost penetrated, and at that time, in the spring, the soil was free from it. On the level prairie, in the vicinity of Edmonton, the frost penetrated to a depth of seven feet during the winter of 1858, while the next winter it penetrated only to a depth of six feet. The former year there was scarcely any snow, which accounts for the greater depth of frost. It may possibly remain in the ground all summer in a swamp, but cannot remain in a fairly dry soil all the year round, except the mean annual temperature fall below freezing point or 32° Fahr. It is well known that a coating of moss or straw will keep the frost in the ground till June in Ontario, so that I should not be surprised to hear of frozen soil in Manitoba in July. Captain Palliser found that the ground, three feet below the surface, grew colder until about the 25th February, when the temperature began gradually to increase; but it was not until the 23rd of May, that it had risen to 32°. From this, I would infer that the great depth to which the soil is frozen in winter is beneficial to the growing crops both as a fertilizer and as a retainer of moisture.

Owing to the light snowfall in the North-West a very few warm days melt all the snow, and almost immediately growth commences. Six weeks after, the frost is out of the soil just three feet, and by last year's meteorological report three inches of rain have fallen, and this, although it has disappeared from the surface, cannot be more than three feet below it. Applying this principle throughout the whole region, we have a permanent supply of moisture during May and June, and one of the factors for the luxuriant vegetation observed by myself on Peace River, and Prof. Nördenskjold in Siberia. A constant supply of moisture, with from 14 to 18 hours' sunshine per day, must cause a growth second only to that of the tropics.

The meteorological report of last year has already given data to show that the rainfall of Manitoba for spring and summer is nearly that of Ontario.

Manitoba	mean for spring,	6·42 inches;	mean for summer,	6·69	inches.
Ontario	" "	6·29 "	" "	8·32	"

This, taken in connection with the fact of the frost retaining the moisture in the soil, and the scantier evaporation caused by higher latitudes, gives Manitoba a greater rainfall than Ontario, and ensures it against our frequent drought. On the other hand, the light rainfall of the autumn, taken in connection with the small amount of snow (which never thaws, but evaporates) during the winter, produces an immense amount of fodder every season, over an area not less than 300,000 square miles. It is the light rainfall of the autumn and the setting in of winter without it that gives the nutritious hay grass that cattle and horses eat on the plains all winter. This is the true reason why these animals come in fat from the plains in spring; and cattle fed when the snow gets too deep for them to find food on the plains would winter just as well as the horses.

All that has been said and written about the nutritious grasses of the prairie resolves itself into this—the frosts and suns of October kill and dry the grass; the November snows cover it up to a depth of a few inches, and so it remains till spring, if not eaten in the meantime.

Condensed Summary of Lands available for Settlement West of Lake of the Woods.

If a line be drawn from the Boundary Line whe e it is intersected by the 95th meridian in a north-westerly direction to where the 122nd meridian intersects the 61st parallel, we shall have the base of an isosceles triangle, which has its apex on the 115th meridian, where it intersects the 49th parallel, one side being the Boundary Line and the other the Rocky Mountains. This triangle encloses at least 300,000 square miles, or over 200,000,000 acres of land.

These lands may be roughly classed as follows :—

—	Square Miles.	Acres.	Arable.	Pastures, Lakes and Swamps.
I. Manitoba (First Prairie Steppe)....	15,000	9,600,000	8,000,000	1,600,000
II. Dry arid Pastures...	8,000	5,120,000	200,000	4,920,000
III. Prairies and Copse Woods	80,000	51,200,000	30,720,000	20,480,000
IV. Forest Country	140,000	89,600,000	25,000,000	64,600,000
V. Peace River Country	70,000	41,800,000	16,000,000	28,800,000
	303,000	200,320,000	79,920,000	120,400,000

These five areas may be generally described as follows:—

Description of the Five Areas.

I. Manitoba.—This, which lies entirely in The First Prairie Steppe, needs no further description.

II. Dry Arid Pastures.—These comprise that part of the area between the 103rd and 108th meridians, having the Boundary Line for a diameter, and from the Boundary to the Elbow of the South Saskatchewan for a radius. On these lands the grass seldom forms a sod, and the rainfall is deficient.

III. Immediately surrounding the above is the "Prairie and Copse Wood Section." Here the grass forms a sod, and the treeless prairie passes by easy gradations into poplar copse, which eventually becomes continuous forest.

IV. This section extends from the west side of Lake Winnipeg, and includes the Saskatchewan country below Fort à La Corne, the basin of the Upper Churchill, and also that of the Athabasca from the Forks of the Clearwater to the Rocky Mountains.

V. The Peace River section includes all the lands drained by that great river east of the Rocky Mountains. From the Mountains to below Smoky River the land is principally prairie, but, after that, it passes into a poplar forest, which extends to the River Laiard, north of the 61st parallel.

Although the figures given above look imposing, they do not come up to the reality. Placing the arable lands at 80,000,000 acres, we have about the same number for pasture and hay lands, and over 40,000,000, or one-fifth of the whole, for lake, marsh and swamp. The preceding part of this report will show where those lands are located, and my reasons for assuming so high a percentage as being fit for raising grain.

JOHN MACOUN, M.A.,
Professor of Botany, Albert College.

APPENDIX Y.

PROGRESS REPORT ON THE SURVEYS MADE IN THE WESTERN PRAIRIE REGION, AND ON THE EASTERN SLOPE OF THE ROCKY MOUNTAINS, IN 1876, BY HENRY A. F. MACLEOD.

OTTAWA, 22nd February, 1877.

SIR,—I have the honour to submit the following report on the explorations, preliminary and location surveys, for the Canadian Pacific Railway, made during the season of 1876, in the North-West Territories, between Livingstone (Fort Pelly,) and the summit of the Yellow Head Pass, Rocky Mountains.

At the date of my last report, 28th March, 1876, the two parties under Messrs. Lucas and Ruttan, were engaged in making the location surveys between Edmonton and the Caledonia Valley.

They had completed the exploratory survey between Livingstone and Root River, near the McLeod, and in the beginning of January, 1876, returned from Carleton, and commenced the location surveys to the west of Edmonton, as described further on.

The distance from Edmonton to the summit of the Yellow Head Pass is 255¾ miles. Trial surveys were made over the greater part of this during the season of 1876, and 160 miles were located, leaving 95¾ miles yet to be located. The plans and profiles of the portion not located show a line laid down denoting the proposed location.

A re-examination was also made by Mr. Lucas, of the difficult ground between the Willow Hills and the summit west of Buffalo Coolé.

Having completed my office work in Ottawa, you again desired me to return to the North-West, to superintend the surveys, and to make a re examination of several localities over which the surveys of 1875 passed, in order to reduce construction work. The portion from the Willow Hills to Buffalo Coolé, south of the four Blackfoot Hills was particularly mentioned, I having led you to suppose that a more favourable line could be found, by keeping more to the south, in the valley of Battle River.

You also wished me to make a further examination of the telegraph line between Livingstone and Edmonton, which by the terms of the contract (No. 2) should have been completed on the first of July, 1876.

On the 27th of April, I sent a requisition to Mr. Robson, the Purveyor in British Columbia, to forward three months provisions for Messrs. Lucas and Ruttan, to the "Athabaska Depot," to be delivered in July, which I computed would be a sufficient supply to complete the location surveys, and would carry the parties back to Fort Carlton, and I wrote on the subject to Messrs. Lucas and Ruttan.

In compliance with your instructions, I proceeded to Winnipeg; arrived there on the 14th of July, and made preparations for the journey to the Mountains.

In Winnipeg I found that the contract for carrying our mails to Edmonton had expired, and that no mail matter had been forwarded for June or July; also that the telegraph line between Livingstone and Winnipeg had not been in operation for a month, and that several messages for the west were still detained at Winnipeg. On the 18th July the telegraph line was again in working order to Battleford, and the erection of the line was completed to Edmonton.

At Winnipeg I telegraphed to Mr. Robson, British Columbia, that two parties, in all 70 men, at work east of Yellow Head Pass, were depending upon supplies ordered from Kamloops, and asked him to hurry them in. I also ascertained from Mr. Fuller what quantity of provisions could be obtained from him at Battleford. To enable Messrs. Lucas and Ruttan to make a further examination of the 100 miles south of the four Blackfoot Hills, I gave a requisition to Mr. Nixon to send one month's supplies for each party, to the telegraph station about 100 miles west of Battleford.

My preparations being completed, I left Winnipeg for Edmonton on the 22nd of July. The crops along the road were magnificent, particularly in the vicinity of Portage La Prairie. There was no appearance of grasshoppers in the Province, the first I met were to the west of Shoal Lake; they were numerous at Fort Ellice, and as far west as the Pheasant Hill Plains.

On the 4th August, we passed Touchwood Hill Post, where I learnt that the buffalo were within two days of the post, which is much further east and north than they have been for years. Next day I met Mr. Crompton returning to Winnipeg, having been obliged to leave Mr. Lucas' party from illness. He reported that all was going on favourably with the parties when he left, but the progress made was not so great as I expected.

I reached the survey and telegraph line on the 7th August, where the trail to the middle ferry intersects it, and followed the line to the next trail west, taking notes of the country over which the location should be made.

The grass was so heavy, and the country so hilly, that it told very much upon my horses, and I had to give up my intention of crossing the South Saskatchewan at the railway crossing, and make for the upper ferry, which I crossed on the 9th August.

At Battleford, I received a telegram from Mr. N. T. MacLeod, informing me that the supply of provisions was very small at Edmonton, that the Hudson's Bay Company there were entirely out, and that by the last news from the parties in the mountains no supplies had as yet arrived from Kamloops. I also met Messrs. Brodie and Harvey, who were forced to leave Mr. Ruttan's party, having been rendered unable for work through an attack of scurvy. I learned from them a good deal of the state of Divisions P. and L.

Mr. MacLeod informed me that he had sent a requisition from Mr. Lucas for a month's supplies to Mr. Clark, Hudson's Bay Company, Carleton, and asked me to see that the provisions were dispatched as soon as possible. I wrote to Mr. Clark, and asked him to comply with Mr. Lucas' requisition, and at the same time to send a like quantity for Mr. Ruttan, to Edmonton. Mr. Clark replied that he would forward the supplies at once. I also bought one month's supplies from Mr. Fuller, at Battleford, for each party, including ten oxen, with carts.

These were to follow me in charge of one of my party, whom I left behind. He was also to hire some men required in the field, who were to act as drivers of the ox train. I had thus provided three months' supplies for each party, which would be available should the stores from Kamloops not arrive, of which their appeared to be considerable uncertainty. My own supplies were also replenished, so as to enable me to make the journey to the summit and back without drawing upon the provisions of the surveying parties.

Mr. Fuller, the telegraph contractor at Battleford, succeeded in growing some very fine barley, also wheat, oats, potatoes, and garden vegetables, including cucumbers and onions, by simply breaking up the prairie and sowing on the sod, the same season.

The buffalo were very numerous a short distance from Battleford, some of them were hunted within a mile of the new police barracks.

I left Battleford on the 15th of August, and in the afternoon met Mr. Fuller's men returning, having completed the erection of the telegraph to the longitude of Edmonton. On the 16th I commenced the examination of the valley of Battle River. I left the surveyed line at 331 miles out from Livingston, following a course generally N 80 W, and joined the line again near the 360th mile.

Having proceeded about four miles in the above direction, I met a high ridge of the Willow Hills extending four miles to the south across the line I was following, which obliged me to turn in that direction. I found Battle River flowing to the south of this ridge, and continued my traverse up its north bank. The banks are very rough and broken, with high hills, rising immediately to the north, 400 feet above the level of the river. I had considerable difficulty in getting my buckboard through this rough country. Some streams run in from the north with large aud deep valleys, so that I found the construction of the railway in this direction would be more costly than along the line surveyed, which is also more direct, if the line south of the four Blackfoot hills can be improved.

Having followed the banks of Battle River for about seven miles, I took a course N 66 west, which enabled me to pass to the north of the most westerly of the Willow Hills, and to join our surveyed line at Station 3192.

I again left our surveyed line at Station 3664, and made a traverse to the south to examine the coolé that runs through this valley, and to ascertain the position of Battle River, &c.

Having proceeded about eight miles, and not finding any trace of Battle River, I determined to follow the direction of our surveyed line to the west; in doing so I was obliged to pass over a succession of deep valleys and ridges running nearly at right angles to my course, varying in height from 100 to 200 feet. In about fourteen miles I came upon a coolé running westwards into Battle River, and in five miles more came upon the banks of the river. I struck Battle River near the north corner of a sudden bend which it makes to the north, and found that Grizzly Bear Coolé runs into it at the north end of the bend. The banks are very rough and broken, standing 400 feet above the river, and they are cut up by deep coolés and streams from the north. After crossing Grizzly Bear Coolé I continued in a westerly direction, and found that the ground rose in a successions of plateaux to a height of 600 feet above the river in a distance of 6 miles. I connected my traverse with the surveyed line at Station 100 or 402 miles out from Livingston.

From the information thus obtained I decided that no more favourable line can be found near the valley of Battle River than the present survey line, and that all improvements must be made within a short distance of this line, as set out on the ground. Being nearly straight, it has the advantage of being the most direct between governing points, the south of the four Blackfoot Hills and the south of the Beaver Hills.

I wrote to Mr. Smith on the 30th August, from Edmonton, that I had come to this conclusion, and Mr. Lucas has since, from actual surveys, ascertained that this portion of the surveyed line can be much improved and probably shortened.

There is a better crossing of Buffalo Coolé about half a mile to the north of the one surveyed. I examined the coolé for 2½ miles to the north and found that it did not improve, and that the hills became higher to the west and east.

I continued my journey along the telegraph line, passed the south of the Beaver Hills, and arrived at the telegraph station on the Hay Lake trail to Edmonton on the 24th August. From this point I was enabled to communicate by telegraph with the office in Ottawa.

From the telegraph station I followed the line westward to the longitude of Edmonton. The line passes over some high hilly ground to the east of White Mud Coolé, on the water-shed between Battle River and the Saskatchewan.

It would appear as though the Beaver Hills and Pigeon Hills formed a continuous range over which the line must pass. The crossing of White Mud Coolé is heavy; the approach on the east can be improved by deflecting the line to the south. West of the coolé the construction of the line is easy to the crossing of the Saskatchewan.

I arrived in Edmonton on the 26th August, received letters from Messrs. Lucas and Ruttan, and ascertained what progress the parties were making.

From the letters received I learned that the surveys were not so far advanced as I estimated they would be; that the supplies from Kamloops had not arrived, and that they might not arrive for some time on account of the high water in the Myette;

also that the parties would soon be getting short of supplies, whilst I found that the Hudson's Bay Company at Edmonton were almost entirely out of provisions. I communicated with Mr. Smith on the above matters by letter on the 30th August, and also wrote to Messrs. Lucas and Ruttan, telling them of the arrangements I had made for supplies from the east, and forwarded their mail by special messenger.

I was engaged in Edmonton for some time in getting the packing gear fitted for the journey to the mountains. My horses required rest, and I made some exchanges, as some were not able to go on further at the time.

The commissariat officers of Divisions P and L, arrived on the 3rd September, bringing the news that both parties were on their way out, without completing the location surveys. The expected supplies from Kamloops had not arrived at Athabasca Depôt up to the 26th August. The health of both parties was seriously impaired by the exposure of last winter, and probably from want of sufficient change in diet. I telegraphed to Mr. Smith informing him of this, and that I could not say that the parties would recommence work till I should meet them, which I expected to do in a few days.

In the meantime I was anxiously looking out for the supplies from Battleford, and sent out some carts to lighten them over the heavy roads near the Hay Lakes. The first regular mail from the Post-Office Department arrived on the 1st of September and returned the same day.

On the 5th September I set out for the mountains.

I met Mr. Lucas and his party at Round Lake on the 8th. He and many of his party were suffering from what appeared to be symptoms of scurvy, and did not feel equal to continuing work in the field for any lengthened period.

Mr. Lucas has, in all cases, succeeded in finding a favourable line over the new portions of the country on which I reported last season. The distance has been shortened by about 26 miles. I continued my journey on the 9th to the Lobstick, where I met Mr. Ruttan and party; many of them were in a bad state of health, suffering apparently from the same malady as Mr. Lucas' party, and almost all were badly provided with clothing.

As there was no certainty of supplies reaching Athabasca Depôt this season from the western side of the mountains, and as it would be almost impossible to supply a party in the mountains by using dogs from Edmonton, taking into account also the bad condition of the men for winter work, I decided to abandon location surveys for the present to the west of the McLeod.

I therefore directed Mr. Ruttan to complete the location of the line between the Pembina and Saskatchewan, a distance of about 40 miles, arranging that Mr. Lucas should make a re-examination of the line surveyed by him, between the summit west of Buffalo Coolé and the Willow Hills, by making extensive cross traverses with levels and by surveying new crossings of the coolés. The remainder of the working season was fully occupied in making these surveys.

On the 12th, I met the last of Mr. Ruttan's packers, from whom I got his plans, which I revised, and took notes of the principal difficulties which he encountered. We arrived at Root River on the 13th, and followed Mr. Lucas' new trail across Wolf River to the McLeod. There is a good deal of wet, marshy country in this section, and the trail, in consequence of recent heavy rains, was very bad.

On the 16th we arrived at the mouth of Medicine Lodge Creek, where the location line crosses the McLeod.

Mr. Lucas has ascertained this season that Medicine Lodge does not flow from "Swamp Lake," as Valad informed me last year; it takes its rise more to the north, near the Athabasca, and flows in a south-easterly direction to within eight miles of its mouth, when it turns to the east. Several other streams run across the country, flowing into the McLeod before the watershed is reached, but Mr. Lucas had no difficulty in leaving the valley of Medicine Lodge and getting across the country to the watershed of the Athabasca, near Swamp Lake, and into the valley of that river, in the direction of my projected line of last year. There are some large extents of marshy ground here, and the trail is anything but good, so that

my horses suffered very much from this cause, and also from the scarcity of pasture.

On leaving Marsh Lake the line passes over a spur of the Foot Hills, being the highest ground that must be crossed to the east of the Yellow Head Pass. The elevation is almost identical with that ascertained by me with aneroids last year. The line then descends into the Athabasca Valley to Sandstone Creek. Mr. Lucas' survey joins Mr. Ruttan's a short distance to the west of this high ground.

After crossing Sandstone Creek on the 20th September, I met the party of eight men who were sent over the mountains from Kamloops with supplies for Divisions P and L. They had stored the provisions at Athabasca Depôt, and were taking twenty-four horses and twenty-one cattle to Edmonton for the winter, in accordance with instructions left by Mr. Ruttan, to be acted on, should they arrive after Mr. Ruttan's return to Edmonton.

I desired Mr. Trapp and another to return with me to the Athabasca Depôt, to remain in charge of the stores there during the winter; the rest of the party went on with the stock to Edmonton.

I then continued my journey up the valley of the Athabasca to the lower end of Lac Brulé where the line crosses. The ground between this point and Prairie River is very rough and hilly, and the work will be heavy. Mr. Ruttan was obliged to give up the lower crossing of the Athabasca near Hardisty Creek in consequence of high precipitous cliffs to the east of Freeman's Creek.

It was found impracticable to descend to Freeman's Creek from this high ground.

I arrived at Athabasca Depot on the 24th September, and found the cargo of provisions stored there; another train load was expected to arrive daily. Mr. Trapp took charge of the stores for the winter.

Near the first crossing of the Myette I met the expected train, with supplies from Tête Jaune Cache. The train went on to the depôt and discharged. This load made the supply stored to be about 20,000 lbs., mostly of flour.

The Myette river was still very high, and it was as much as horses could do to ford it. The trail crosses the Myette several times before reaching the summit, so that in high water the road is almost impassable.

I took notes of the topography and character of the country on the way up and down. On the 27th I reached the summit of the Yellow Head Pass, and found Mr. Keefer's marks and benches, and also Mr. Moberly's. I went about half a mile further, found the water flowing towards the Fraser, and commenced my return towards the east.

I found that the waters of the Myette, in floods, sometimes divide and flow partly to the Fraser, so that it would not be difficult to divert the whole stream in that direction. This would effect a large saving in the construction of the line in the valley of the Myette; particularly at Horse Rapids, where it would otherwise be necessary to divert the river into an old channel. I have since been informed that the waters of the Myette would not cause any serious inconvenience to the line west of the summit if made to flow into the Fraser.

The empty train passed us on its way to Kamloops; we got back to the depôt on the 28th. I crossed the Athabasca below the mouth of the Maligne on a raft, and followed our trail of last year to near Fiddle River. Here I made an examination of the Athabasca, with a view to crossing it above Fiddle River, or at another point just below Roche Myette. This would avoid the heavy work at Bulrush Point, and the crossing of the Assiniboine; but against this saving we would have to cross Fiddle River, and the line would pass through the drifting sand hills along the east shore of Lac Brulé. The crossing of the Athabasca would also be heavier than the crossing at the foot of Lac Brulé. It is, however, in my opinion, worth trying before the final location is made.

On my return I kept to our trail of last year, as it is generally on higher ground. We had a heavy gale on the 4th of October at White Mud Lake, which filled our trail through the burnt country with fallen timber, and caused us endless trouble till we got to Root River. In many places the trail was more full of timber than before it

was commenced; we could make no headway through it, and had to leave it and make circuits for considerable distances. I examined the crossings of the McLeod, Beaver Creek, and Wolf River on my return, and found that the best in the vicinity had been selected.

At the Lobstick I followed down the south bank along the located line to near its mouth to see if a better crossing of the Pembina above the Lobstick could be found, but it appeared to me impracticable to reach that point on the east bank of the Pembina, in consequence of the high and precipitous nature of its banks, between it and the small stream coming down from the watershed, which the location line now follows.

From the Pembina to White Earth Fort, I followed Ruttan's trail, passing to the south of White Lake. The location line is generally close to the trail, the country is hilly, particularly to the east of White Lake, and there is a considerable elevation to be overcome before getting into the valley of the Saskatchewan. The valley of White Earth is crossed, and the line makes a considerable bend to the north to avoid low ground near the Saskatchewan, and to facilitate the ascent to high ground lying more to the east. I went on to the crossing of the Saskatchewan and examined it, with the approach on the west side. The crossing can be made more nearly square, and the line shortened by raising the grade, and placing the line higher up the hill on each side of the river.

I examined another crossing, three-quarters of a mile up the river to the south. A survey was made of this, which shows that the approach on east side follows a very crooked deep valley, where the work would be heavy. The approach on the west side would also be heavier than the lower crossing.

The country between the lowest crossing of the Saskatchewan and the east side of White Lake was not examined last year, so that it became necessary to make trial surveys in advance of location, as the line of last year was some miles to the south of the present location.

I returned to the White Earth Trail, which I followed to Edmonton, arriving there on the 18th October. Here I found Mr. Ruttan making final preparations for his journey to Winnipeg. His party had gone down the river on a boat built by themselves, intending to reach Carleton before taking to carts.

I found that a large extent of the country about Edmonton had lately been on fire, and that a large quantity of hay, cut, had been destroyed. It was consequently difficult to keep stock together, and the supply of hay would probably be short before next spring.

I therefore decided to send all the horses and mules to Bow River for the winter, in charge of some men from British Columbia, who could not be sent back at that season of the year. There was sufficient hay secured to keep the cattle at Edmonton, and I put Mr. McGinn, who accompanied me from Winnipeg, in charge of the cattle and Government stores at that place. My horses were not in a condition to proceed further, and the other horses could not be found just then, on account of the fires. I therefore decided to get a boat built, and to endeavour to get to Carleton by water, where I would be able to get some horses and dogs from Mr. Ruttan.

The boat being ready, I started the 22nd October down the Saskatchewan. Mr. Ruttan left by land on the 21st, to overtake his horses and carts.

The water in the river was very low, with numerous rapids, full of large stones and boulders, so that we had great difficulty in getting down, and several narrow escapes from being upset. We passed Fort Victoria on the 25th. The river is very crooked; the distance by it must be twice as great, as in a direct line. At and below Dog Rump Creek the river becomes much obstructed with extensive sand bars, which fill the bed of the river in every direction, making it impossible to follow the channel. In some places they were quite out of the river, in others only covered with a few inches of water forming the only visible channel for the water of the river.

We had heavy rain and snow on the 29th and 30th October, and ice was forming

in the river; taking into consideration the shallowness of the water to the east of Fort Pitt, we decided to sell the boat there and take horses to Carleton.

We reached Fort Pitt on the 30th, where we were very kindly treated by Mr. McKay of the's Hudson Bay Company, who supplied us with horses. The snow was now about a foot deep. We ferried the river on the 1st November, and continued our journey to Battleford, where we arrived on the 4th, and at Carleton on the 10th. Mr. Ruttan and his party started from Carleton on the 16th.

We set out from Carleton on the 14th November and followed the road from the middle ferry to the forks of the Quill Lake trail, then the Quill Lake trail for some distance and struck across to the telegraph line, which we followed for a considerable distance. We passed the telegraph station at Big Stone Lake on the 18th and followed the line to the Quill Lake trail. The road led us along the north of Quill Lake for a considerable distance, till we got to the north end of the Touchwood Hills. We passed the new mail station on the 20th, and arrived at Fort Pelly on the 24th.

I went to Livingstone, and examined some miles of the telegraph line to the west, through the woods.

From Fort Pelly, I followed the trail passing over the south of the Riding Mountains, and took some notes of the widths and depths of the valleys of the Assiniboine, Bird Tail Creek, &c.

At the Little Saskatchewan I left my horses to follow slowly, and went on with dog trains to Portage La Prairie. Here I met the regular stage to Winnipeg, arrived there on the 8th December and reached Ottawa on the 4th of January, 1877.

I shall now allude to the surveys, described in the following sections:—

1. Location survey, Edmonton to River Pembina.
2. do. do. River Pembina to River McLeod.
3. Exploratory survey, River McLeod to summit east of River Athabasca.
4. do. do. summit east of River Athabasca to River Mountain Assiniboine.
5. Location survey, River Mountain Assiniboine, to River Myette.
6. Exploratory survey, River Myette to summit of Yellow Head Pass.

Edmonton to River Pembina.

Mr. Ruttan, and Division L, having arrived from Carlton and Fort Pitt, recommenced the survey at the Hay Lakes, on the 4th of February, 1876.

As before stated, I found it necessary to run another trial line from Hay Lakes to the longitude of Edmonton, to ascertain the nature of the country between those points, and to enable the contractor to build the telegraph on the proper line.

From the end of this trial line at the longitude of Edmonton, the location survey was commenced, and extended westerly, crossing the Saskatchewan at a point about twenty miles below the proposed crossing of last year (1875).

The heavy side hill work along the south bank of the river will thus be avoided, but it became necessary to survey a new trial line between this new crossing and White Lake.

Having completed this trial line on the 10th May, Mr. Ruttan thought it advisable to go to the Athabaska and execute the surveys in that locality.

On the 9th September he returned to complete the location between the Saskatchewan and Pembina, which was effected on the 15th October, 1876.

The country between the longitude of Edmonton, near the 1,197th mile, and the Saskatchewan is very even and presents no difficulties to the construction of the railway. The work will be light over this portion and will average from 3 to 5 feet for embankments and cuttings. There is a coolé at 1,210 miles which increases rapidly in size towards the Saskatchewan; the line is deflected to the north after having crossed it.

The approaches to the Saskatchewan between the 1,215th and 1,219th miles are along the banks of the river, on rough side-hill ground; the works will be heavy, cuttings and embankments averaging about 20′ deep.

The line, as at present located, crosses the river at an angle of 45°, and at an elevation above the bed of the river of 104 feet, requiring a bridge about 1,200 feet long. By raising the grade 10 or 15 feet the crossing could be made more nearly square, the bridge would be shortened, the approaches located higher up the side-hill, and placed upon safer ground.

From the 1,219th mile to a large coolé at the 1,222nd mile the country is undulating and the work light; formation principally from side ditches.

The crossing of this coolé is very heavy, it being 90 feet deep below formation level.

The crossing might be improved by lengthening the line a little and swinging it more to the north; towards the south the coolé increases rapidly in size; even with the present crossing the line to the west can be changed to obtain a profile, as shown by the dotted line.

The work on the ascent to the 1,224th mile is moderately heavy, about eight feet of cutting; this would probably be reduced on a line more to the north.

From the 1,224th to 1,226th mile the work is light, embankment about three feet.

The country becomes hilly and difficult between the 1,226th and 1,232½ miles, and the work is heavy, cuttings and embankments about 10 feet; at the last named distance there is a large coolé, which increases considerably in size to the south as it approaches the Saskatchewan. The bottom of the coolé is 63 feet below formation level.

From the coolé to the crossing of White Lake Creek, 1,237 miles, the country continues hilly, though the work is not so heavy, probably six feet for cuttings and embankments.

The crossing of White Lake Creek is very heavy, the coolé being 100 feet deep, and 500 feet wide at top. It cannot be much improved, as there is high ground about half a mile to the east.

From White Lake Creek to 1,241½ miles, the line rises rapidly to overcome some high ground between the Saskatchewan and White Lake.

The country is very hilly and broken, and the work will be heavy, probably ten feet for cuttings and embankments.

It continues much of the same character to White Lake, 1,244 miles, cuttings and embankments about 15 feet. Between 1,244 and 1,254½ miles the line crosses a small bay of White Lake, 2,000 feet wide, and three feet deep (nine feet in the channel.)

It then follows a natural beach of the lake for 1½ miles; the rest is generally along the foot of high ground to th esouth and north.

The work here will be light, embankments about three feet deep.

From 1,254½ to 1,259 miles the country is hilly and broken, and the work heavy, probably about fifteen feet for cuttings and embankments. The work might be reduced in quantity by bending the line a little to conform more to the contour of the hills.

Between 1,259 and 1,260½ miles the work is light, embankments about three feet deep.

From 1,260½ to 1,264 miles the country is hilly, and the work heavy; the cuttings and embankments will average about 20 feet. This portion might also be improved in places, by changing the position of the line round the hills.

Alignment.

On this distance of 67½ miles there are :—

57	miles of straight line	or nearly 85	per cent.
2½	" " curves of and under 1°	or nearly 4	" "
3¾	" " " from 1° to 2°	or nearly 5	" "
3¾	" " " " 2° to 3°	or nearly 5½	" "
½	" " " " 3° to 4°	or nearly ½	" "

Gradients on Same.

$14\frac{3}{4}$ miles of level	.................................or nearly	22	per	cent.
$8\frac{3}{4}$ "	from 0 to 0·25 per 100..........or nearly	13	"	"
$13\frac{1}{2}$ "	" 0·25 to 0·50 per 100......or nearly	20	"	"
14 "	" 0·50 to 0·75 per 100....or nearly	21	"	"
$16\frac{1}{2}$ "	" 0·75 to 1·00 per 100.....or nearly	24	"	"

A better line than the one located may perhaps be found by leaving it near the 1,232nd mile, passing to the north of White Lake, and joining the line again some distance to the west of the lake, there would be probably little difference in the length of the two lines.

The new line would have to cross a wide bay at the north east end of White Lake, and would have to pass over very hilly country to the north and east of the same, It would, however, be well to examine this route before proceeding with the construction of the more southern line.

The portion of the line to the west of the 1,264th mile was located by Mr. Lucas.

River Pembina to River McLeod.

Mr. Lucas, and Division P having arrived at Edmonton from Carleton, on the 24th January, and 8th February, 1876, they proceeded to make tracings of Mr. Ruttan's plans and profiles, and other plans required for use in the field.

The location survey was commenced at the Pembina on the 3rd March, and continued easterly about three miles to the junction of Mr. Ruttan's location. It was then carried on westerly to the McLeod River, which was reached on the 28th July.

From this point a trial survey was made to near the Athabasca, thirty and a half miles; on the plan a projected location has been laid down.

This survey was completed on the 28th August, connecting the line with the survey made by Mr. Ruttan a few weeks before.

Commencing at the 1,264th mile, the line soon descends to the crossing of the Pembina which is reached near the 1,267th mile. This approach is very heavy and difficult, the watershed between the Saskatchewan and Pembina being so near the latter river. The depths of cuttings and embankments on this portion will be from 10 to 40 feet.

The crossing of the Pembina is heavy. The waterway should be 500 feet; the height from formation level to the bottom of the river is 95 feet.

From the Pembina to the crossing of the Lobstick at $1,268\frac{1}{2}$ miles, the work is very heavy. The line passes along the side of a precipitous sandstone cliff, and the embankments are high, and require protection on the south side. The highest of the embankments here will be about 40 feet, and the cuttings about 75 feet.

This part of the line may possibly be improved by making a tunnel through the rocky narrow ridge east of the 1,268th mile. The line might then be straightened and the grades lowered.

The first crossing of the Lobstick is 55 feet high to formation level, and requires a waterway of 100 feet.

The work is heavy in the valley of the Lobstick until the even ground is reached near the 1,273rd mile, the cuttings and embankments will generally average about 15 feet. This valley is very crooked with bold abrupt banks: the river is very rapid, and flows generally on sandstone rock. It will be necessary to make two diversions of the river; the first near the 1,270th mile, will easily be effected, the second, near the 1,271st mile, will be difficult. The line can be located more to the south, and thus give more room for the diversion on the north side. It is probable that the river may be diverted round a hill about a quarter of a mile to the north, through what appears to be an old channel; but this will require further examination.

For the next three miles the work is light up to the 1,276th mile. The em-

bankments will be about three feet, except at the crossing of three streams, where they will range from 13 to 25 feet.

Between the 1,276th mile and the last crossing of the Lobstick near the 1,301st mile, the country is undulating, rising in high ridges to the south of the line, which still keeps in the valley of the Lobstick.

Several large streams cross the line flowing into the Lobstick, and into Chip Lake, requiring embankments ranging from ten to twenty-five feet for short distances; the remainder of the work is light, cuttings and embankments about three feet.

The last crossing of the Lobstick is thirty-five feet high to formation level and will require a water way of eighty feet.

From the Lobstick the line ascends rapidly to overcome the water-shed between the Rivers Pembina and McLeod—at 1,303½ miles. The work is not heavy, and will probably average five feet in cuttings and embankments. Several other lines were surveyed over this divide in the endeavour to get a more direct line; the located line is the most favourable as far as known.

On crossing this water-shed the line immediately descends to Moose River, a branch of the McLeod—at the 1,308th mile. The work on this portion is light and will probably be under five feet for cuttings and embankments.

The crossing of Moose River is heavy, being fifty feet high to formation level—the embankments and cuttings on both sides will average about thirty feet for a distance of 2,000 feet.

On the remainder of the line to Root River, at 1,310½ miles, the work is light, cuttings and embankments about five feet.

The crossing of Root River is 20 feet high, with a water-way of 40 feet. The line then follows the valley of Root River, and of a small stream flowing into the same, leaving the line surveyed in 1873 a considerable distance to the north. This portion up to the 1,316th mile is light—the cuttings and embankments will average about three feet.

Between this point and the crossing of Wolf River, the country is very marshy—the work is moderately heavy, and will average about eight feet for cuttings and embankments.

The crossing of Wolf River, at the 1,321st mile is 33 feet high, and will require a waterway of 100 feet.

The ground ascends rapidly for two miles west of Wolf River, and is of a wet, marshy character; the embankments and cuttings are moderately heavy, and will average about five feet.

From the 1,323rd mile to Beaver Creek the country is wet and marshy in places; the work is light, probably from 3 to 5 feet embankments. The valley of Beaver Creek is 45 feet deep below formation level, and about 600 feet wide; the stream will require a water-way of 80 feet.

Between Beaver Creek and the 1,320th mile the country is more undulating and less marshy; the work on this part is moderately heavy, averaging about eight feet for cuttings and embankments.

At the 1,320th mile a deep valley is passed, requiring an embankment 30 feet high for 1,200 feet.

Between this point and the 1,333rd mile the work is light, and will average about five feet for embankments and cuttings.

There is a deep coolé near the 1,333rd mile which will require an embankment 75 feet high and 300 feet long, with an allowance for waterway of 80 feet.

The line now approaches the McLeod, the banks of which are high and bold.

From the coolé above-mentioned to 1,336½ miles, near the crossing, the work is heavy, and will probably average about 10 feet for cuttings and embankments.

River McLeod to summit east of River Athabaska.

Mr. Lucas made a trial survey of this part, and a projected location has been marked on the plans, not very far removed from the trial line.

The crossing of the McLeod is 75 feet high from the bottom of the river to formation level, requiring a waterway of 300 feet. The embankments on both sides are heavy, averaging 30 feet deep for 2,000 feet. The line here joins the survey of 1873, and runs parallel with it for some miles, when it again leaves it as it returns to the valley of the McLeod over the Grand Portage.

From this point to the 1,338th mile the work is moderately heavy, and will average 15 feet for cuttings and embankments. The line follows close to the waters of Medicine Lodge Creek, which it will be necessary to divert for a short distance.

Between the 1,338th and 1,344th miles the work will be light and the ground, dry, the cuttings and embankments will average about three feet.

The crossing of Medicine Lodge Creek is about 20 feet high, with a waterway of 60 feet. The embankment on both sides is about 20 feet high, and 3,000 feet long.

The line here leaves the valley of the Medicine Lodge, and strikes across the country towards the watershed between the McLeod and Athabasca.

From 1,344½ miles, for three miles, the work is light, averaging about three feet for cuttings and embankments.

Near the 1,348th mile the line crosses a deep valley, requiring an embankment 35 feet high and 1,500 long. Between this point and 1,353 miles, the line passes over a ridge and again descends to a stream at the above distance. The work on this portion is light, probably from three to five feet for cuttings and embankments. The character of the ground is wet and marshy.

The work for 1½ miles west of this stream is moderately heavy, averaging from five to ten feet for cuttings and embankments.

From 1,354½ miles to the watershed between the McLeod and Athabasca at 1,357 miles, the work is light, about three feet for cuttings embankments, except one embankment in the 1,356th mile, which is 15 feet deep for 1,500 feet.

From this watershed to a large stream running into the Athabasca at 1,359 miles the average of cuttings and embankments will be about five feet.

The crossing of this stream is about 25 feet high, with a waterway of 80 feet.

From this stream for about a mile west, the cuttings and embankments will average about five feet. The ground here becomes wet and swampy.

Between the 1,360th and 1,362nd miles the country is swampy, and the work light, not exeeeding three feet for embankments.

The line then ascends rapidly till it reaches the highest ground, over which the line passes, east of the Yellow Head summit, at the 1,364th mile. It here traverses a narrow valley with high hills on each side. The work on this part is light, and will not exceed five feet for cuttings and embankments.

The descent from this point into the valley of the Athabasca is rapid for some miles. The junction with Mr. Ruttan's line was made near the 1,367th mile. The work on this part descending from the summit, is moderately light, from five to eight feet for cuttings and embankments, except a cutting at the 1,366th mile, which is 20 feet deep for 1,000 feet. This cutting cannot well be avoided, as there is a bold bluff point running out a considerable distance into the valley, which must be crossed.

Alignment.

On these two sections of 103 miles there are.

80	miles of straight line........	or nearly	78	per cent.
9⅓	do " curves of and under 1°............	or nearly	9	per cent.
6⅓	do " " from 1° to 2°............	"	6	"
4⅓	do " " " 2° to 3°............	"	4	"
3	do " " " 3° to 4°............	"	3	"

Gradients on same.

23	miles of level..	or nearly	22	per cent.
8	do from 0 to 0·25 per 100......................	or nearly	8	per cent.
20½	do " 0·25 to 0·50 "	"	20	"
18¼	do " 0·50 to 0·75 "	"	18	"
33¼	do " 0·75 to 1·00 "	"	32	"

After completing this survey, Mr. Lucas made some surveys in the vicinity of the Four Blackfoot Hills, as above mentioned.

Summit East of River Athabasca to River Mountain Assiniboine.

Mr. Ruttan, with Division L, commenced work in the Athabasca Valley on 15th June. The trial survey between the 1,367th and the 1,433rd mile, near the mouth of the Myette, was completed on the 9th August, and the location survey between the Mountain Assiniboine, and the Henry House on the 28th August.

Commencing on the 1,367th mile the line continues to descend into the valley of the Athabasca.

For the first two miles the work is moderately heavy, and will average about eight feet for cuttings and embankments, besides the crossings of a large stream near the 1,368th mile, the bottom of which is 75 feet below formation level. It will require a water-way of 40 feet.

From the 1,369th to the 1,372nd mile the line is on side hill and the work heavy: it will probably average eight feet for cuttings and 25 feet for embankments. A stream is crossed in the 1,372nd mile, whose bed is 75 feet below formation level, requiring a water-way of 20 feet.

Between the 1,372nd and the 1,374th miles, the line continues to descend along side hill ground. The cuttings and embankments will average eight feet. A large stream is crossed in a deep coolé, near the 1,373rd mile, 85 feet from bed to formation level. It requires a waterway of 30 feet.

The country becomes more even between the 1,374th and the 1,378th miles, and the work is light, about five feet for cuttings and embankments. A stream is crossed near the 1,374th mile, requiring a waterway of 30 feet, and Sandstone Creek near the 1378th mile, waterway 20 feet. There is about half a mile of side hill work to the east of Sandstone Creek. The line follows a very even terrace between the hills and the river from the 1,378th to the 1,385th miles, with light work varying from three to five feet for cuttings and embankments.

Coal Creek, a considerable stream, passes under ground in the 1,382nd mile, and appears again some distance below the line.

Hardisty Creek is crossed in the 1,383rd mile, it will require a waterway of 100 feet, and is 20 feet from bed to formation level.

For the next mile and a half the line is partly on side hill; the work is light and will average about five feet for cuttings and embankments.

The work on each side of Prairie River, with the line as at present projected, is very heavy between 1,386½ and 1,387 miles, averaging for embankments about 30 feet and for cuttings 15 feet.

The hills to the south of the river are high, bold and abrupt, forming a deep crescent with bold points projecting towards the line. The portion to the west of the river rises along side hill ground; it is believed a better line can be got by keeping to the south, and conforming more closely to the shape of the hills. It will, however, be necessary to pass over the high ground east of the 1,387th mile.

The country continues hilly and rough to the crossing of the Athabasca, in some places the valley is narrow and confined. The work is heavy between the 1,389th and 1,391st miles—embankments about twenty feet, and cuttings about fifteen feet.

A large coolé is crossed at the 1390th mile, sixty feet from bed of stream to formation level.

On the next mile the work is moderately heavy. from five to ten feet.

From the 1392nd to the crossing of the Athabasca at the 1,396th mile the line is generally along side hill, and the work heavy, from ten to twenty feet.

The line crosses the Athabasca at an angle of 52 degrees, and will require an opening of 600 feet in this direction. The height from bed of river to formation level is 50 feet. This is the narrowest crossing of the Athabasca.

Freeman's Creek, a large stream, empties into the river near the crossing, and can be diverted along the north of the railway.

From the crossing of the Athabasca to 1,397½ miles the ground is hilly and the work heavy, averaging about 15 feet for cuttings and embankments.

For the next six miles the line follows along the foot of the Bulrush Mountains along the western shore of Lac Brulé to Bulrush Point at 1,403½ miles. The work along this portion is moderately heavy, averaging about five feet for cuttings, and twenty feet for embankments. There is a large stream at the 1,403rd mile which will need attention, and which requires water way of 80 feet.

It is proposed to have two tunnels in the Bulrush Points, one 1,600 feet long and the other 350 feet. The third point will be an open cutting about 50 feet by 200 feet. The bays of the river between the points to be made up of the rock from the tunnels and cutting.

Between Bulrush Point and 1,407 miles the embankment is heavy; kept high as the Athabaska at this point is liable to rise to a considerable height. The embankments will average about eight feet. The cutting is very light and the filling will be made up from side borrowing.

From the 1,407th mile to the crossing of the Mountain Assiniboine the line passes through low marshy flats, on which the work is light, running from three to five feet.

An elbow in a side channel, which causes a serious deflection in the line, is passed near the 1,408th mile. Another side channel is crossed twice near the 1,409th and 1,410th mile. This channel can be diverted, and the material used for embankment.

River Mountain Assiniboine to River Myette.

The line from the Assiniboine to the Henry House has been located, but it would be well to throw the line at the crossing of the Assiniboine, say, one half a mile to the north, as shown on plans and profiles, so as to get a safer crossing, where the stream issues from the rocks. Below that point the stream spreads very much over the ground in high water, even in the direction of the line to the east, so that ordinary embankments would not be safe. This proposed crossing will require a waterway of 700 feet, and about 20 feet from bed of stream to grade.

From the Assiniboine to the 1,414½ mile the work is moderately heavy, and will average about eight feet for embankments and cuttings.

The line then passes over a high point, through which it is proposed to make a tunnel 250 feet long, with open cuttings at the ends. From this point the line descends a long side hill, till Jasper Lake is reached, 1,416 miles. This part will be heavy and will average 20 feet for cuttings and embankments. There will probably be rock in the lower part of these cuttings. One of the cuttings is 50 feet deep and 300 feet long.

The line follows the shore of Jasper Lake from the 1,414th to the 1,419th mile; it passes over several points of rock running into the lake, in one of which, near the 1,419th mile it is proposed to make a tunnel 225 feet long. The embankments on this portion will run from 10 to 15 feet, and the cuttings about 15 feet.

Between the 1,419th and the 1,421st miles the work is light, about five feet for cuttings and fillings.

White Moose Creek is crossed near the 1,421st mile, and it is proposed to divert it to a 30 feet structure to the west. It will be necessary to protect the diversion for about 600 feet.

On the next mile the work is moderately heavy, cuttings and embankment from eight to fifteen feet.

From 1,422 to 1,425 miles the work is light, averaging from three to five feet embankments. Snaring River is crossed in the 1,425th mile. This is a rapid, dangerous torrent; great care will be required in the construction of the bridge, and in protecting the banks of the stream for some distance to the west. It would have been better to have crossed the river where it issues from the rocks, but the ground is there too high, as compared with the approaches on each side. The line would also be lengthened by doing so.

Work on the next mile is heavy; embankments from eight to 20 feet, and cuttings about 10 feet. Several streams are to be diverted to a structure of 40 feet opening.

The work is light between 1,426 and 1,429$\frac{1}{2}$ miles, averaging from three to 10 feet. A stream requiring a 20 feet opening is crossed at 1,428 miles, 30 feet from bed to formation level.

On the next mile the work is moderately heavy, cutting 15 feet and embankment 20 feet. The line approaches close to the Athabasca River at this embankment.

From 1420$\frac{1}{2}$ to 1432 miles, the work is light, about five feet for cuttings and embankments. There are two places where the line will require a small amount of protection, where it approaches the river, near the Athabasca Depôt.

The last mile to the end of the location Survey (at 1,433 miles) is moderately heavy, and may involve some rock excavation. The cuttings and embankments will average about 10 feet.

Alignment.

On these two sections of 66 miles there are,—

$50\frac{3}{4}$	miles of straight line	....or nearly	77	per cent.
$5\frac{1}{2}$	" curves of and under 1°	.... "	8	"
$5\frac{1}{4}$	" " from 1° to 2°	.... "	8	"
$3\frac{1}{4}$	" " " 2° to 3°	.... "	5	"
$1\frac{1}{4}$	" " " 3° to 4°	.... "	2	"

Gradients on same.

$21\frac{3}{4}$	miles of Level	....or nearly	32	per cent.
$8\frac{3}{4}$	" from 0 to 0.25 per 100	.... "	13	"
12	" " 0.25 to 0.50 "	.... "	19	"
$9\frac{3}{4}$	" " 0.50 to 0.75 "	.... "	15	"
$13\frac{3}{4}$	" " 0.75 to 1.00 "	.... "	21	"

Having finished this survey Mr. Ruttan and party returned eastward, and completed the location of the line between the Saskatchewan and Pembina as above described.

River Myette to summit Yellow Head Pass.

A trial survey of this portion was made in 1872–73. The projected location is close to the trial line, and is based upon it, and upon further exploration made by me in 1876.

Commencing at the 1,433rd mile the line which is now in the Athabasca Valley near the river, begins to ascend, for the purpose of passing over a point of land, which runs out to the junction of the Myette and Athabasca. It then follows up the Myette, or Caledonia valley, to the summit.

On the first mile the work is light, and will average from three to five feet for cuttings and embankments.

On the second mile the ascent is more rapid, and is along side hill; the work will average about five feet for cuttings and 15 feet for embankments.

From the 1,435th to the 1,437th mile the work is moderately heavy, about 10 feet for cuttings and embankments. There will be rock excavation in passing over the numerous spurs of the hills, along the base of which the line runs.

On the next three miles the work is light, probably about five feet for cuttings and embankments.

The Myette is crossed in the 1,440th mile; it will require a waterway of 200 feet.

The waters of the Myette can be diverted into British Columbia at the summit, and a large amount of heavy work saved in the valley of the Myette. There are

still some large streams flowing into the Myette to the east of the summit, and it is necessary to keep the waterway large for those mountain streams, even when the Myette is diverted.

The work on the 1,441st mile is light, from three to five feet embankments.

On the next $2\frac{1}{2}$ miles the valley ascends rapidly, and the work on the line will be heavy, envolving embankments averaging about 13 feet, and rock cuttings on steep side hill. The embankments will be made up principally from side borrowing.

A large rapid stream is crossed at the 1,443rd mile, which will require a waterway of 100 feet.

Between $1,443\frac{1}{2}$ and 1,451 miles, the work is light, from three to five feet for cuttings and embankments.

The Myette River is crossed again near the 1,447th mile, and will require a waterway of 80 feet.

Glen's Brook, at 1,449 miles, should have a waterway of 60 feet. There are two small points of rock to be cut through in this distance. The soil of the valley of the Myette is generally soft and marshy, and will probably require attention in some places before the embankment is commenced. Very much of this is caused by beaver dams, which are numerous here. The side drains of the railway will have the effect of lowering the water on the flats.

From 1,451 to $1,452\frac{1}{4}$ miles, at the summit of the Yellow Head Pass, the work is moderately heavy along side hill, averaging about eight feet for cuttings and embankments. There will be some rock excavation on the side hill. The Myette is crossed again close to the summit, but it is proposed to divert it into British Columbia, which can be effected by deepening an old channel in that direction, and building a dam of crib wharfing a short distance up the stream.

Alignment.

On this distance of $19\frac{1}{3}$ miles there are :—

13	miles of straight line	or nearly	67	per cent.
$\frac{3}{4}$	" curves of and under 1°	"	4	"
$2\frac{1}{3}$	" " from 1° to 2°	"	12	"
$1\frac{1}{2}$	" " " 2° to 3°	"	8	"
$1\frac{3}{4}$	" " " 3° to 4°	"	9	"

Gradients on same.

$3\frac{2}{3}$	miles of level	or nearly	19	per cent.
4	" from 0· to 0·25	"	21	"
$4\frac{2}{3}$	" " 0·25 to 0.50	"	23	"
2	" " 0·50 to 0·75	"	11	"
5	" " 0·75 to 1·00	"	26	"

Building Materials.

Between Edmonton and the summit the kind of timber that most generally prevails is spruce. It is found in large quantities in almost all parts of this country, sound and of good size, from eight to thirty inches.

There is also a large quantity of tamarac in the marshes, running from six to twelve inches. Pitch pine is abundant, but it is very inferior in quality for timber.

I have seen no white or red pine between the Lake of the Woods and the summit, except three small trees of red pine near Marsh Lake, on the Athabasca.

Poplar is very plentiful in all parts of the country. There is some very large about White Lake, and in some other valleys. It decreases in size as the mountains are approached.

Birch is only found in small quantities, on banks of lakes and rivers. I am not aware that there is any oak in the country.

Almost all the rock found in situ east of the Rocky Mountains on this section is composed of sandstone. That in the valley of the Saskatchewan is soft as far as known, but would probably improve in the quarry. In the valleys of the McLeod and Athabasca it is harder and well suited for building purposes.

Limestone boulders are found in abundance in all the rivers, which would furnish large quantities of lime.

The most eastern ranges of the Rocky Mountains are very largely composed of limestone.

In the valley of the Myette gneissoid rocks appear, alternating with slate and coarse sandstone.

Coal is found in large veins in all the river valleys to the east of the Rocky Mountains as far as Edmonton, and it is reported to exist in the Mountain Assiniboine, but of this I have no positive knowledge.

There will not likely be any scarcity of ballast as a very large portion of the country is made up of gravel and sand ridges.

Soil and Capabilities for Settlement.

The land to the south of Edmonton and extending westward to the Saskatchewan is very good, and well adapted for settlement. It is sufficiently free from woods to permit of agricultural operations being commenced at once, and at the same time furnishes abundant timber for building purposes, and for fuel.

From the Saskatchewan to Chip Lake large areas of the country can be successfully cultivated, when cleared, particularly about White Earth and White Lake. There are also large prairies in this section.

From Chip Lake to the summit the soil becomes more clayey and requires drainage. No doubt if the land were cleared the soil would become dryer.

On this section there are several places where good farms can be found, such as the valleys of Moose and Root Rivers, the valleys of the McLeod and Medicine Lodge, the Prairies of the Athabasca, the valley of Prairie River, and even the prairie in the Myette, near the summit.

It is to be regretted that owing to the non-arrival of supplies from the western side of the mountains, the survey was left in a less perfect condition than was intended by your instructions. It is only right, however, that I should allude to the circumstances which conduced to the failure of getting supplies in to the parties. Amongst them may be mentioned the highness of the water in the Fraser, which delayed the pack trains in British Columbia for several months, and prevented their arrival at Athabasca depôt till September. Those supplies were ordered to be there, and were required in July.

The lowness of the water in the Saskatchewan, which only permitted the Hudson's Bay Co.'s steamer to make half a trip, namely, from Carlton to Edmonton, thus reducing the usual stock of provisions this side of the mountains.

The failure of the buffalo in the vicinity of Edmonton, which reduced the usual supply of pemican.

The failure of the crops about Edmonton, making all provisions scarce, and the stoppage of our mails, which prevented the delivery of letters, and kept all parties concerned in ignorance of the actual state of affairs.

The two parties engaged in these surveys underwent a considerable amount of hardship in the winter of 1875-'76. First in their journey from Hay Lakes to Carleton, and then from Carleton to Edmonton, both in mid-winter. It is fortunate that all escaped without casualties of any kind, in journeys of such duration, with such scarcity of shelter as exists in the Western plains.

The difficulties of forwarding supplies to the west of Edmonton were very serious, and the transport available was limited, so that many articles not absolutely necessary were left behind, thereby causing sickness for want of change in diet.

All the members of the staff have performed their work in a satisfactory manner, and have endeavoured to carry on the work successfully.

I have the honour to be, Sir,

Your obedient servant,

HENRY A. F. McLEOD.

SANDFORD FLEMING, Esq.,
Engineer in Chief,
Canadian Pacific Railway.

APPENDIX Z.

MEMORANDA RESPECTING THE WINTER CLIMATE OF THE ROCKY MOUNTAINS, BY GEORGE A. KEEFER, C.E.

A general idea of the character of that portion of the Rocky Mountains extending from the summit of Yellow Head Pass some 200 miles westwards, can be formed from the attached summary of meteorological observations, taken respectively at Tête Jaune Cache, lat. 53·04 N., during the winter of 1875-'76, and from Mr. Jarvis' record of temperature, taken *en route* during his Smoky River expedition in the winter of 1874-'75; while that of the eastern slope can be judged from a similar summary taken from Capt. Palliser's report and notes, taken from Edmonton to Jasper House in January and February, 1859, and a copy of Mr. Moberly's summary of observations, taken at Athabasca Depôt during the winter of 1872-'73, published in Mr. Fleming's report of 1874, accompanied by a short report of the "General characteristics of the winter climate of the Rocky Mountains, more particularly that of Yellow Head Pass and its approaches." (See Appendix P., Mr. Fleming's report of 1874.) Taken conjointly, these observations will aid in giving a correct idea of the winter temperature of the Mountains.

The observations taken at Tête Jaune Cache were at an altitude of 24·25 above sea-level, and 50 miles west of the summit, the extreme elevation of which, in the Yellow Head Pass, is 3,734 feet above sea-level. Those of Mr. Jarvis varied from an elevation of 1,940 at Fort George, to 5,300 feet at the summit. Those of Capt. Palliser and Mr. Moberly, at Athabasca Depôt, 3,340 feet above the same datum, and extend from January to April, inclusive, in their respective years.

As will be seen, for the western slope, the winter of 1875 exceeded in severity that of 1876, and the difference is not to be ascribed to the effect of altitude, as Mr. Jarvis experienced his coldest weather while in the neighbourhood of Fort George, or about latitude 54° N., on the 14th of January, when the thermometer registered the low temperature of 53° below zero. The lowest point reached at Tête Jaune Cache was on the 21st of January, the thermometer registering 40° below zero, this month being, in both cases, the coldest experienced.

While the winter 1874-'75 was colder than that of 1875-'76, the latter, as far as our records extend, exceeded any previous year in the excessive snow-fall, which reached an aggregate of 112 inches. The greatest depth at any time remaining on the ground, varied from four feet at the summit to five feet at the foot of Moose Lake, at which point it was deeper than elsewhere in the valley, and on the 15th of May was still lying with a depth of three feet.

On the lower portion of the river, from three and a half to four feet in depth is about the average, that is in the bottom of the valley; on the upper benches it was of course much deeper. This unusual snow-fall apparently extended to the eastern slope of the mountains, reaching an average depth of from 15 to 18 inches at the Athabasca Depôt, while Mr. Moberly's report for the corresponding months in the winter of 1872-'73 mentions six inches as the greatest depth at any one time remaining. Capt. Palliser mentions a fall of some 22 inches in the Athabasca Valley on the 21st January, 1859, about half way between Edmonton and Jasper House, but a later record, from February 10th to 16th, taken in the immediate vicinity of Jasper House, would seem to substantiate Mr. Moberley's experience of the same locality, there being five days of light snow in that time; so that, in the absence of further data, and from all the information I could obtain, it is safe to assume that the snow-fall of the winter of 1875-'76 was extended and exceptionally heavy. It was owing to this cause that the Athabasca Valley, hitherto considered a safe place for wintering stock,

proved very disastrous to ours, as from the great depth of snow it was impossible for the animals to obtain sufficient food, and although I have reason to know that every effort was made by those in charge, only 20 out of the 45 animals, horses and mules, comprising the pack train, remained alive in the spring, and these were so reduced as to be unfit for work for some time; out of ten head of cattle sent for Mr. McLeod, four died before the rest were killed. This valley is exposed to the north-easterly winds, which are very prevalent during the winter months, and in the sheltered spots the snow was too deep for feed to be reached, hence our heavy loss in stock. On the 26th of May they were able to reach the summit and join my division.

One peculiarity noticeable in the winters in this region is the absence of any heavy continuous fall of snow, such as is often experienced in Central and Lower Canada, followed by an interval of fine weather. Here, there is a constant succession of light falls, rarely exceeding five inches in depth at one time, and the absence, at any time, of a crust on the snow, making snow shoveling at all times, except on the rivers, heavy work. The excessive cold absorbing all moisture leaves the snow of a salt-like consistency, and it is only late in March and very early in the day that it is compact enough to bear.

The country being heavily timbered, the snow is not disturbed by the wind, but lies at a uniform depth, and I fancy it will only be on the more exposed portion, or on the plateau further west, that any extent of snow sheds will be required. In the immediate vicinity of the glacier streams or mountain torrent there are unmistakeable indications of snow-slides or avalanches, and the *debris* of rocks, earth, and trees is piled, in many cases, to a height of sixty feet, with the torrent directly on the summit, forming an ugly obstacle to railway construction, and one that can only be overcome either by tunnelling, or by some structure allowing any future slide to pass over the road, as from the evidences of the irresistible force exerted by this immense moving mass, there is but little room left for doubt that the structure has yet to be devised that would stand for a moment before it—fortunately they are at an elevation that admits of either of the means mentioned being adopted.

The river after becoming filled with floating ice and being impracticable for canoes, for a week previous, closed on the 19th November, opposite our quarters, and crossing was safe on the following day, and remained so until the middle of April. At any time during the winter great caution is necessary when travelling on the snow, as at most of the bends the strong currents will have rendered the ice unsafe and the danger is concealed by the snow.

The principal tributaries to the River Fraser above this point are the numerous large glacier streams that discharge at frequent intervals into the main river, the water of which is always at a low temperature, averaging about 43°, rising and becoming turbid towards evening, from the action of the sun on the glaciers. Streams easily crossed and fordable in the morning become by evening formidable and difficult from the same cause.

The water in the Fraser and its branches in the spring of 1876, owing to the large amount of snow, followed by the heavy spring rains, was as is generally known, higher than it has been for years, but at this point its height was not so perceptible, being nearer the head waters. It reached its highest point on the 23rd June, some 10 feet above its lowest stage, which was on the 18th April. This excessive flood was, I believe, general throughout British Columbia, and on the lower portion of the Fraser the waggon road was submerged, bridges carried away and all traffic seriously impeded, while on the North Thompson, our supply trains and mails from Kamloops were delayed from the same cause, only reaching the Cache by the end of July, being two months on the journey which, under favourable circumstances, would have been accomplished in about twelve days.

The weather on the western slope during the working season is such as I suppose may be expected at this altitude and in a mountainous district being excessively broken and uncertain. Rain predominates, taking the place of snow in winter, and in constantly recurring showers on an average of nearly four days in the seven, making bush work very disagreeable, and I fancy more personal discomfort

is experienced from this cause in this locality than elsewhere. The finest part of the year is in the early fall, or for the months of September and October when the frosts set in and when there is some respite from the very broken weather of the preceding five months. This term of fine weather is, however, uncertain, and is sometimes of short duration. In the immediate neighbourhood of Tête Jaune Cache, where it is open to the southerly and south-easterly winds from the valley of the Columbia, open weather continues longer than elsewhere, and the snow disappears much earlier. Severe frosts at night are felt here in common with other localities in the neighbourhood, beginning early and extending late into the summer, Water froze in my tent on the 29th of August at this point, and night frosts were common in June; so that out of the twelve months I fancy two and even less would be all that could be relied on as exempt from night frosts, and, consequently, but few cereals could be raised in this locality; but the amount of arable land in the valley of the Fraser is so small that it is hardly likely ever to be taken into consideration. The wide and open valley of the Cranberry opposite the Cache contains a considerable area of dry sandy benches where some of the hardiest vegetables could be raised, but I can hardly consider it will ever be utilized to any great extent on account of the extreme uncertainty of the climate and severity of the early frosts.

The foregoing remarks, when applied to the valley of the Fraser from the summit west, are the result of a personal experience of some fifteen months, beginning in July, 1875, and ending in October, 1876, as well as the experience of those who were in the same locality in the summer of 1874, those on the eastern slope, from the report of my packer who wintered in Athabasca Depôt, and from Mr. Moberley's and Captain Palliser's reports of 1873 and 1859 respectively. I need scarcely add that the usual Canadian pests, black flies and mosquitoes, exist in this region, and are both numerous and troublesome; but the evenings are always cool, and give a respite without which life here would be unbearable.

GEORGE A. KEEFER,

Engineer in Charge,

Division M., C. P. R.

Ottawa, April, 1877.

SUMMARY of Meteorological Observations taken in the Rocky Mountain District, from January, 1859, to April, 1876.

AT TETE JAUNE CACHE.—LAT. 53° 04′ N.

Dates.		Temperature. Mean Minimum Temperature.	Mean Maximum Temperature.	Average Mean Temperature.	Lowest observed Temperature.	Highest observed Temperature.	Number of Days Rain.	Number of Days Snow.	Depth of Snowfall.
	1875.	° ′	° ′	° ′	° ′	° ′			inches.
November	1st to 30th	....	....	....	—30 0	....	12	8	21
December	1st to 31st	....	....	....	—25 0	+36 0	4	15	26
	1876.								
January	1st to 31st	—7 7	+12 2	+2 3	—40 0	+35 0	....	8	25
February	1st to 29th	+6 7	+31 2	+19 0	—21 0	+45 0	....	17	23¼
March	1st to 31st	+9 8	+32 7	+21 3	—25 0	+53 0	2	9	9½
April	1st to 30th	+28 3	+50 5	+39 3	+10 0	+63 0	10	5	7¼
							Total.		112

ON SMOKY RIVER EXPEDITION.—LAT. 54° N.

	1874.								
January	1st to 31st	—25 2	....	....	—53 0	....	....	....	....
February	1st to 28th	+6 6	....	....	—29 0	....	....	....	....
March	1st to 31st	+0 8	....	....	—30 0	....	....	....	....

CAPT. PALLISER'S EXPEDITION—EDMONTON TO JASPER.

	1859.								
January	1st to 31st	—2 0	....	....	—28 0	....	16	15	25
February	1st to 16th	—2 0	....	....	—23 0	....	11	5	6
							Total		31

MR. MOBERLY—ATHABASCA DEPOT.—LAT. 52° 56′ N.

	1873.								
January	1st to 31st	+0 5	....	+9 2	—26 5	+42 7	1	9	4
February	1st to 28th	+4 4	....	+14 7	—24 5	+39 3	0	5	2
March	1st to 31st	+17 3	....	+28 2	—11 0	+59 3	2	4	6½
April	1st to 11th	+25 3	....	+36 1	+16 5	+59 5	0	0	0
							Total		12½

APPENDIX Z. (A)

PROGRESS REPORT ON SURVEYS CARRIED ON DURING THE YEAR 1876, BY MARCUS SMITH.

OTTAWA, 20th April, 1877.

SIR,—I have the honour to Report on the progress of the Surveys for the Canadian Pacific Railway during the year 1876.

Western or Mountain Region.

The surveys projected for the season, were :—

1. The completion of the trial location from Tête Jaune Cache, to the neighbourhood of Fort George.

2. A re-survey and location of the line through the heart of the Cascade Mountains by the valley of the Homathco, following the East branch.

These two surveys were necessary to complete the trial location of the line (No. 6 of former Reports) from the Yellowhead Pass, in the Rocky Mountains, to Waddington Harbour, at the head of Bute Inlet.

3. A trial location survey of the line (No. 8 of former Reports) from Kamsquot Bay, in Dean Channel, through the Cascade Mountains by the Kamsquot or Salmon River, a distance of about 52 miles ; and an exploratory survey, in continuation of this line, by the Rivers Nechacoh and Stewart, to the mouths of the Chilacoh, about 15 miles west of Fort George, where it joins the line No. 6, referred to in Sections 1 and 2.

4. An exploratory instrumental survey of a proposed deviation of a portion of the line No. 8, as surveyed the previous year, between the valleys of the Chilacoh and Blackwater.

To carry out these surveys, two parties were engaged between the Yellowhead Pass and Fort George during the previous season ; they passed the winter of 1875–6 in camp, making exploratory surveys ; one party, with Mr. George A. Keefer in charge, had their winter quarters at Tête Jaune Cache, and the other, under Mr. H. P. Bell, wintered in the neighbourhood of Fort George. These two parties continued the location of the line during the season of 1876.

The Engineering Staff for three Divisions, under the charge of Messrs. C. H. Gamsby, J. T. Jennings and D. MacMillan, were appointed in Ottawa, and left on the 19th April for Victoria, British Columbia, where they arrived early in May, and made up the complement of men required for their respective parties.

Two other parties were organized in Victoria under the charge of Mr. John Trutch and Mr. Joseph Hunter.

As I had to take the general charge as Acting Engineer-in-Chief during your absence in England, Mr. H. J. Cambie was appointed to superintend the surveying operations in British Columbia.

At the close of the season all the surveys that had been projected were completed, together with a trial survey between Lytton and Fort Yale, about 53 miles, on the most difficult portion of the valley of the Fraser.

Also some explorations were made on the east side of the Cascade Mountains, near the sources of the River Nechacoh and Lake François. For a report of these operations, see Appendix K.

I have already given you a description of the engineering features of the several lines embraced in the above surveys, designated as Routes No. 2, 6 and 8, in former reports (see Appendix T).

Central or Prairie Region.

A location survey from Selkirk (Red River) to Livingstone, 271 miles, was completed in 1875, and in 1876 exploratory surveys were continued from that point westward by two parties, with Mr. D. E. R. Lucas and Mr. H. N. Ruttan in charge, under the general direction of Mr. H. A. F. MacLeod. They remained out all the winter of 1875-6, and by the close of last season they had joined their surveys with those carried on from the Pacific coast through the Yellow Head Pass. A full description of the operations of these parties is given by Mr. MacLeod (see Appendix Y).

Eastern or Woodland Region.

The line from Fort William, Lake Superior, to English River, 113 miles, had been previously located, and part of it put under contract for construction.

Four survey parties were organized, under the charge of Messrs. W. A. Austin, A. Brunel, H. I. Mortimer and E. G. Garden, to continue the location of the line from English River to Keewatin, at the outlet of the Lake of the Woods, a distance of 183 miles. These parties were under the general direction of Mr. S. Hazlewood, as District Engineer. They commenced operations at the opening of the navigation of the lakes.

The line thence to Selkirk (Red River) had been previously located, and part of it put under contract for construction.

It was arranged to make an exploration of the country from a point on French River, where it could be bridged, north-westward on a line as direct as practicable to the north shore of Lake Superior, near the mouth of the River Pic.

This was put into three divisions; Mr. T. Ridout was placed in charge of the eastern division, Mr. Charles Horetzky of the central, and Mr. J. L. P. O'Hanly of the western division.

A survey had been previously made from this point westward, along the shore of Lake Superior and Nepigon Bay, to the River Nepigon, and Mr. L. G. Bell was instructed to make an exploration from that point westward by Dog Lake to a point on the line under construction, from Fort William westward.

A party was organized under the charge of Mr. H. D. Lumsden to make a trial location survey from Contin's Bay on French River, about twenty miles from its mouth, to Lac Amable-du-Fond, the proposed eastern terminus of the Canadian Pacific Railway.

I accompanied this party from Toronto, and at Collingwood found my assistant Mr. T. R. Burpe waiting for me with the Indians whom he had engaged as canoemen for an exploration which I proposed to make of the country around Lake Nipissing, and thence westward to the Spanish River on the north of Lake Huron.

We reached the mouth of the French River on the evening of the 27th of July, on the steamer "Silver Spray," and disembarking our stores and camp equipage we took quarters in the house erected by the Hon. A. B. Foster, the contractor for the Georgian Bay branch. In two days more we reached Contin's Bay, and camped near the point where it was proposed to commence the survey.

Mr. Lumsden and myself took a canoe, and went up to the head of the Bay, about six miles, where the Pickerel River comes in, and where the line of the proposed survey again touches the bay, after having diverged to a considerable distance from it. I think it very probable that this may prove the best place for the terminus of the Georgian Bay branch, or for the depôt on French River, if the main line should pass through this point, as the bay is wide, giving room for vessels to swing, and the water is deep, except on a sand bar about 2,000 feet in length, on which it is only about ten feet in depth. Should this require to be dredged, I think the expense would be small compared to that of constructing a railway six or seven miles in length, over rather rough ground.

I therefore directed Mr. Lumsden to run a trial line westward from this point,

across the several branches of the French River to ascertain approximately the bridging that would be required, and to get a profile of the country adjoining.

On the 1st August, Mr. Lumsden's party commenced the survey, and I proceeded up the French River with two canoes and five men; on the third day we reached Lake Nipissing and crossed over to the Hudson's Bay Company's Post, on the north side of the lake about a mile up the Sturgeon River.

Here we spent a day maturing our plans. We purchased a large sized canoe, engaged another Indian to complete her crew, and sent back the two smaller canoes to Mr. Lumsden's camp. We then made the circuit of Lake Nipissing from the mouth of the Sturgeon River to the entrance of the western arm or bay on the south side of the lake, which we did not follow up, but crossed over to the Hudson's Bay Company's post, where we had left our stores. This occupied four days, as we were delayed the greater part of one day by high winds, which made the lake too rough for canoe navigation.

The French River is really a chain of lakes, stretching between Lake Nipissing and the Georgian Bay. These are separated by clusters of islands into numerous channels and cross arms, and connected by a series of falls and short rapids, forming so many steps or portages between stretches of still water most favourable for navigation. On the south branch, by which we travelled, there are eight or nine of these portages, the longest of which is about 1,500 feet, at the first fall from Lake Nipissing, called "The Chaudière." Below this, there is a rather strong current for about a mile; and there is another current at the "Petite Dalles," about a mile and a half from the Georgian Bay.

Nearly all the country immediately adjoining the river is composed of gneissoid rock. We saw scarcely any soil until we reached Contin's Bay, where there are probably 200 to 300 acres of good soil—a sandy loam—part of which is cultivated by the Indians, who raise very good corn, potatoes and other vegetables; they also make large quantities of sugar from the maple growing on this land.

In the neighbourhood of the Chaudière there is some good land, of sandy loam, covered with sugar maple and other hardwoods, interspersed with pine and spruce.

The timber on the river generally consists of pine, balsam, birch, cedar, spruce, and tamarac, the proportion of these varying in different localities. A considerable extent of the country has been burned, and large quantities of valuable timber destroyed. Away from the river there are basins and narrow valleys between the ridges of rock, consisting of a stiff clay soil.

At the mouths of the Rivers Sturgeon and Beuve, on the north shore of Lake Nipissing, near the west end, there are extensive flats of good land. Following the shore eastward, the land is low and favourable for railway construction. A large portion of this is an Indian reservation, on which there is an Indian village; a French trader has a good house on Duke's Point. After passing this point the shore recedes northward near to the mouth of Silver River; it then takes a course nearly west for about eight miles. From this shore a low flat extends several miles to the north, and is densely covered with soft maple, mixed with tamarac, birch, cedar and ash.

The shore line then bends to the south-east. and is indented with small bays or bights that have been washed out of the alluvial benches by the waves of the lake. These bights run to the foot of a ridge formed of harder matter, extending in a north-westerly and south-easterly direction, and rising to a height of apparently 200 to 300 feet above the level of the lake.

We camped over Sunday on a small farm cultivated by an Indian family, and were detained there till four p.m. next day by high winds, we then ventured out and before night set in, reached the small round bay at the east end of the Lake and camped near a farm homestead, the second we had seen since we left the Hudson's Bay Company's post.

This bay is so shallow, that rushes crop up above the water; the country immediately around it is low but rocky. A depression at the east end of this appears to afford a feasible line for a railway to the Ottawa valley.

From this bay, round a projecting point to South River, the country bordering on the lake is low and swampy, with rocks protruding. There is some very fine land and pine timber in the valley of the South River, in which there are a number of settlements. On the south side of the valley the country rises to a considerable height. I estimated it roughly as 300 to 400 feet above the level of Lake Nipissing, but following the shore of the latter in a north-westerly direction, it falls to within 100 to 150 feet of the level of the lake. It consists, however, chiefly of rocks and swamps, along the whole of the south shore of the lake to its western extremity.

On our return to the Hudson's Bay Company's post, we met Mr. Ridout and one of his staff. They had found good crossings of the two branches of the French River, below the Chaudière Falls, and were working north westwards by a chain of lakelets in a series of narrow valleys between rocky ridges, which gave promise of a favourable line for the railway.

On the 10th of August, with two canoes well manned, we started up the River Beuve, which falls into the eggshaped bay of Lake Nipissing lying to the west of Sturgeon River. This bay is about five miles long and two and a half wide, and on its margin there is very fine land, covered with soft maple, birch, ash and other hardwood.

We travelled two days up this river, in a generally north-west direction, and made a distance of about twenty-five miles, to where the river is divided into two branches, having traversed in our course a number of short portages, at rapids, falls, and jams of drift-wood.

Although this is but a small stream, it is dammed up at intervals by low rocky ridges crossing it and forming stretches of dead water like canals, 100 to 150 feet wide on the lower portion, but decreasing to sixty feet at the forks. The land in the valley of this stream appears very rich, covered with maple and other hardwoods, and there has been a large quantity of good pine on the slopes, which has been nearly all destroyed by fire.

We intended to go to Lake Nepewasing, out of which the south branch of the Beuve flows, and thence to cross, by a portage of three or four miles, to Elbow Lake, which discharges into the River Wahnapitaepee; but, above the forks, there was not water enough to float our canoes, and we were reluctantly compelled to return to our camp on Lake Nipissing.

We had the choice of two routes, one up the Sturgeon River, from which, with a few very short portages, there is a communication, by a chain of narrow lakes, with Lake Wahnapitaepee, out of which the river of the same name flows southward, and joins the French River not far from its mouth, on the Georgian Bay: or, we might cross Lake Nipissing, descend the French River, to the mouth of the Wahnapitaepee, and ascend the latter to any point desired. We took this route, as we had left some supplies at the depot on French River, to be forwarded up the Wahnapitaepee.

On the 16th of August, we passed Mr. Lumsden's camp, on the trial line westward across the French River, and the same evening we reached the depôt; next day we started up the River Wahnapitaepee, and on the 18th we met Mr. Tupper, the purveyor of Mr. Ridout's party, about five miles south of Salter's base line. He informed us that the party had reached a point within a short distance of the river, and had found a very feasible route, but were driven some distance south of the direct line by high rocky ridges crossing their course. The same evening, we reached Salter's line, where we found Mr. Ridout camped, and our supplies stored.

The Wahnapitaepee is a beautiful river, 150 to 180 feet wide on the lower section, and 100 to 160 feet near Elbow Lake, about thirty-five miles up from its mouth, on which distance there are thirteen portages, but most of them are short.

For the first ten miles the country is very rocky, and the timber has been burned; beyond that the land near the river is low and swampy, up to within five miles of Elbow Lake, with occasional low ridges of rock protruding.

On the 19th of August we made an excursion up Elbow Lake, which is about six miles long, surrounded with rocky ridges rising two or three hundred feet above the level of the lake. Returning, we followed the river up five or six miles to the portage between it and Long Lake, where we camped over Sunday.

Next morning, we went about three miles up the river, and ascending a hill 300 feet high, had an extensive view of the surrounding country, which to the north-west and east was very rough and broken, with high rocky hills, which would, to some extent, govern the line to be explored for the railway.

I had now sufficient knowledge of the location to enable me to give Mr. Ridout definite instructions as to the route westward that offered the best prospect of success, and from subsequent observations in passing down Long Lake, I did not anticipate any very serious engineering difficulties till reaching the vicinity of Vermilion River.

On the 21st of August we resumed our journey westward, taking the route by the Long, Round and Whitefish Lakes, the Vermilion and Spanish Rivers to Lake Huron.

The first part of the journey was very tedious, as the waters were low, and the sloughs connecting the chain of small lakes, collectively called Long Lake, were nearly dry, so that we had a great many portages to make, and it took us two days to reach Whitefish Lake. These are beautiful sheets of water, and as the timber on their margins has not been burnt, the freshness and soft, undulating lines of the landscape formed an agreeable contrast to the desolate, rocky and burnt country we had lately traversed. We appeared to be travelling in a basin or plain slightly inclined to the south-west, and shut off from Lake Huron by the chain of La Cloche hills extending along its north shore. There appears to be very little difference of level between Long, Round, Mud and Penage Lakes, which are from 200 to 225 feet above the level of Lake Huron. The Whitefish group are 30 to 40 feet higher. There is some very fine pine timber around these lakes, with some hemlock and patches of maple, birch and other hard woods.

The Vermilion and Spanish are fine rivers, with a considerable quantity of good land and timber on their margins, especially on the latter, from the forks down to within three or four miles of Lake Huron. The journey, however, was tedious, as there were a great many portages to make, some rather long and rough. Our last portage, the seventy-sixth since we entered French River, was about seven miles below the confluence of the Spanish River and Vermilion, or, as it is sometimes called, the East or Whitefish branch. Thence, the river is navigable by steamboats to Lake Huron, about 35 or 40 miles.

On the 26th of August we reached the mouth of the Spanish River, but it had been blowing a gale during the night, which was now increased so that we could not cross to the island on which Mr. Chaffey's mills are situated, and where there is a post office and wharf, at which the coasting steamers stop.

When we arrived there, two days after, we found the coasting steamer "Silver Spray" had passed up during the gale, and there were rumours of the other steamer —"Seymour"—having gone into dock for repairs. So we took advantage of the first calm day, and ran down to Little Current, on Manitoulin Island, intending to take the first steamer up from Collingwood to Lake Superior, but we were again disappointed as the steamer "Cumberland" from Collingwood that week went out of her usual course, and did not call at Little Current.

Through these detentions we did not reach Prince Arthur's Landing, Lake Superior, till the 10th of September; fully ten days later than I had arranged for.

I inspected the greater portion of the line under contract (No. 13) from Fort William to Sunshine Creek, 32½ miles in length, and found the works were being well constructed and advancing towards completion, the grading of 23 miles being finished and the balance well in hand.

The next section is 80 miles in length, extending to English River, 112½ miles from Fort William. This was put under contract (No. 25) three months previous to my visit. The contract embraced the tracklaying and ballasting on both sections, and there were then 14 miles of rails laid from Fort William. The grading and other works were progressing satisfactorily.

Having arranged various business with Mr. Hazlewood, the District Engineer, I made preparations for continuing my journey of inspection westward.

September 14th. —We left Prince Prince Arthur's Landing by the waggon road

for Shebandowan, examining some of the railway works on our way in company with Mr. MacLennan, the resident Engineer. At the Shebandowan we found our Indians with their canoes.

Next day we proceeded by the steam tugs traversing the Lakes Shebandowan, Kashaboiwie and Lac de Mille Lacs, (making the two intervening portages with horses and waggons.) In the evening, we landed on an island in the last lake, where the tug left us.

The navigation of this lake is extremely intricate, owing to the great number of islands with which it is studded, and the very irregular outline of its shore, so that on continuing our journey next day with our canoes, we had great difficulty in finding the outlet. This is called the River Seine, which we followed about 20 miles on a generally westward course (making seven portages) to a tributary coming in from the north.

By this, and a chain of small lakes (with numerous portages intervening), we crossed the height of land ; thence, by another chain of lakes, we reached English River, and examined the located line at the crossing of the same, and for some distance on each side.

A mile and a half below this point the Obush-ke-gah River, a tortuous, sluggish stream, enters English River from the south-west, crossing the railway line between the 112th and 113th mile. We followed up this about ten miles, to its source in a large lake; thence, our course was by a chain of lakes a few miles to the south of the line and generally parallel to it. The portages between these lakes vary from a few yards to four miles in length, so that our progress was slow.

On the third day we reached the Ka-ka-kee River, which flows in a tortuous course through a large flat of swampy ground.

Descending this about twenty miles in a northerly direction, we crossed the located line near the 139th mile, where we camped. I then sent a messenger along the line westward, who found Mr. Austin's party about eight miles distant, to which point they had located the line, and run a trial survey some miles in advance. Mr. Austin came to my camp with the plans and profiles, which I examined, and they showed a very good line for so difficult a country, which is not mountainous, but intersected with very irregular rocky ridges running generally in a north-easterly direction, almost at right angles to the line of railway.

The next party, under Mr. Brunel, were supposed to be about twenty miles west of Mr. Austin's party, but working eastward to meet them. I gave such instructions as I thought would insure the surveys being joined in time for both parties to get back to Lake Superior before the winter set in.

We found we could not get further westward on that route by canoe, so on the afternoon of the 22nd of September we set out on our return journey, and on the third day reached the River Seine. We intended to follow that river down (south-westward) to Sturgeon Falls, at the head of an arm at Rainy Lake, but the Indians gave bad accounts of the rapids and portages, and as our provisions were getting low we reluctantly had to retrace our course back to Lac des Mille Lacs, on which, however, we fortunately had tolerable weather for canoeing and reached the Baril portage on the 28th September at noon; crossing this, we paddled down the Baril Lake and reached Brulé the same evening. The whole journey by canoe from Lac des Mille Lacs and return, occupied twelve days, in which we made fifty-two portages, varying in length from fifty yards to four miles.

At Brulé we found a steam tug ready to go westward next day, so I sent back the Indian crew whom I had engaged at Fort William, and we went on westward on the steam tug to the next portage ; we continued to follow the Red River route, but as the steam tugs were not running very regularly and did not always make connections, we sometimes had to proceed in our canoe, and were frequently delayed by high winds which made the lakes too rough for canoe navigation. Our progress was, therefore, rather slow and tedious, and we only reached Fort Francis on the 4th of October. Here we were detained two days by a snowstorm which covered the ground to a depth of six to eight inches, and caused some alarm to Mr. Brunel's party who feared that the lakes might get frozen before their survey was completed.

The steamboat on the Lake of the Woods was laid up disabled, and the small tug used on Rainy River was away on an arm of the above lake to bring out the parties under Mr. Garden and Mr. Mortimer, who had completed their surveys, so we had to continue our journey down the Rainy River in canoes. In two days we reached Hungry Hall, an abandoned post of the Hudson's Bay Company within two miles of the Lake of the Woods. Here we were storm-bound for three days; the weather being very cold, when fortunately Capt. Wylie's steam tug came down the river with a cargo for the North-west Angle, so I took passage on her for Mr. Burpé and myself, and sent our Indian crew back to be paid off.

The storm having abated, we started next day. 11th October, and at the mouth of the river we met the tug with the surveying parties, who had been six days storm-bound on an island in the Lake of the Woods. In two days we reached the North-west Angle, where we met Mr. Grant the officer in charge of the transport service on the Red River route. Mr. Burpé accompanied him to Winnipeg, and next day I took passage in Capt. Wylie's tug which had a cargo for Rat Portage; we arrived here on the 14th October.

There I found Mr. Fellowes, Assistant Engineer on Section 15 encamped, and, together, we examined some of the most difficult portions of that Section. I gave him some instructions respecting the carrying out of the works, and then returned with the tug to the North-west Angle; thence, with horses and waggon, which Mr. Grant had provided, I travelled to Winnipeg, where I arrived on the 19th of October.

In company with Mr Rowan, District Engineer, we inspected several miles of the grading on the Pembina Branch, which is very well executed. We then drove down to the main line, and examined the place selected for the crossing of the Red River. and afterwards inspected the works on a considerable portion of Contract No. 14. The grading was nearly finished on the first 33 miles, and the bridges were being put up. The side and off-take ditches have not only been successful in thoroughly draining the line of railway, but the portion of the country which was formerly wet is for a considerable distance on each side greatly benefitted.

The soil on the margin of the Assiniboine and Red Rivers, and indeed of the whole country as far as I travelled, is exceedingly rich.

Having completed all necessary arrangements respecting the surveys and works of construction, I left Winnipeg on the 27th October on the steamer "Manitoba," being her last trip of the season. The weather had been cold for some weeks past, but now the Indian Summer had set in, and the trip to Fisher's Landing, occupying three to four days, was delightful. Thence, we travelled by rail homewards, and reached Ottawa on the 7th of November.

Accompanying this is a synopsis of the reports on the explanations made during the past year, on a direct course between a point on French River and the mouth of the River Pic, Lake Superior.

Also, a report on the trial location from Contin's Bay, French River, to the point known as the Eastern Terminus, south of Lake Nipissing.

Also, a general description of the engineering features of the line located from Fort William, Lake Superior, to the summit of the Yellow Head Pass.

EXPLORATIONS BETWEEN FRENCH RIVER AND THE MOUTH OF THE RIVER PIC, LAKE SUPERIOR.

The following is a synopsis of the Reports on explorations made between French River (Lake Huron) and the River Pic, Lake Superior, during the year 1876.

Eastern Division 82½ *miles, Mr. T. Ridout in charge.*

This exploration was commenced on the French River at the Rapids du Pin, about 40 miles up from the Georgian Bay. Here the main branch of the river is

divided by an island having channels on each side of about 100 feet wide, the country east and west being high, rocky and broken. Running north-westward on the course indicated in the instructions for about two miles, the north branch was met with and found to be 900 feet wide with a depth of water of 50 feet. The rough and rocky character of the country in this locality, together with the width of the river crossings, necessited further examination for a more favourable crossing and lower country.

The river was accordingly followed up for a distance of 8½ miles to the Chaudiere Rapids. Here the main stream is contracted to a width of 50 feet, and the country n both directions is much more easy.

There was no examination to the eastward made, further than to observe a depression along which a line could be constructed with a good approach to the river.

The line will follow generally in a westerly direction, along the south shore of the north branch of French River to the seventh mile, passing through some good hard wood land of sandy loam, with frequent points of rock. on this the works will be moderate and the gradients easy. At the 7th mile an arm of the river will be crossed, but the waterway at this point does not exceed 50 feet. Then westward to the 12th mile, the line runs along the large western arm of French River, passing through rocky ridges with intervening swamps, and in some places a good depth of soil. The ridges are not high, so that good gradients can be obtained with moderate works.

From the 12th to the 31st mile the line takes a very direct course, about north 65° west up the north side of a valley, through which flows a small stream which at ntervals expands into a series of long narrow lakes.

The altitude of the stream or lake at the 12th mile is estimated 614 feet above the level of the sea, and at the 31st mile it is 682 feet, giving a rise of a little over two feet per mile.

The country throughout this section has been completely burned over, leaving nothing but dead trees and a tangled mass of fallen timber.

From the 12th to the 17th mile the country is principally rock with very little soil, but as the line follows the depressions, the work will be moderate.

Thence to the 24th mile, the line runs through an open grass valley, and on clay flats, having a good depth of soil and the works will be moderate.

The last point is near the foot of the Lake Wigwassikagamog; the line following its north shore encounters rocky ridges, with good soil intervening; a good deal of the rock is loose, so that the works will not be heavy.

At the 27th mile the line is forced away from the shore of the lake by high rocky ridges, about one mile to the north, where there is a depression, and the rock alternates with swamp and patches of good soil, so that fair gradients can be obtained without inordinate cost.

From the 31st mile the line follows up a narrow valley in the same general direction to the 35th mile; on this the gradients will be easy and the works light.

Thence to the 39th mile, the line, by a tortuous course, crosses the divide from which the streams flow eastward to the French River, and westward to the Wahnapitaepee. On this section there are high ridges of rock, and the works will be heavy. The altitude on the divide is estimated at 760 feet above sea level.

The country to the north-west of this is very rough and broken. so that the line is forced to the southward of the direct general course, and follows a narrow valley in which there is a chain of small lakes, some marsh and tamarac swamp, to the River Wahnapitaepee, which is crossed near the 46th mile.

The formation level at the crossing is estimated 706 feet above sea level, showing a fall of 54 feet in the last seven miles, so that the gradients on this section will be easy and the work moderate, as there are only a few points of rock to cut through.

The Wahnapitaepee at this place is 200 feet wide, having clay banks six feet high, rising on the west side to a rocky ridge 65 feet above the level of the river. Cutting through this ridge, the line continues north-westward to the 48th mile, through a tamarac swamp, and some rolling land having a fair depth of soil.

From the 48th mile the country is so extremely rough and rocky on the general course, that the line is forced northward on a hill side, and across some low ridges of

rock, alternating with meadows and tamarac swamps, having a good depth of soil of clay and sandy loam, affording fair gradients with moderate rock.

From the 36th to the 54th mile the country is thickly wooded with spruce, tamarac, cedar, birch, poplar, hemlock, and occasionally good pine.

From the 54th mile the general course of the line is nearly north to the 59th mile, where it crosses the long narrow valley running south-west, containing the long chain of lakes which discharge into Lakes Penage and Huron. In this section there is a considerable amount of rock, and there are two small lakes so surrounded with rocky hills that it may be necessary to cross them by bridging or embankment to avoid excessive curvature and heavy rock excavation.

From the 59th to 60th mile the line ascends the north slope of the valley on a westward course, with a gradient of 1 per 100. Thence to the 70th mile the course is north-west, passing through stretches of swamp and clay flats of good land up to the 67th mile, with easy gradients and light works; but from this to the 70th mile there is a good deal of rock with broken ground, and though the gradients are easy the work will be heavy.

From the 54th to the 67th mile the country is nearly all burned over; thence, to the 77th mile, there is green bush of birch, balsam, spruce, tamarac, cedar, maple and pine.

The rock hitherto met with has been granite and gneiss, but from the 70th mile the character is changed, and the country becomes very much broken up by high ridges of slate, rendering it necessary to bend northwards, cutting across the ridges to the east end of White Water Lake, and thence to the north of this lake into the valley of a large stream which empties into the Vermilion. There will be heavy works on this section, but easy gradients may be obtained. The highest point on this Division is between the 70th and 71st mile, which is approximately 1000 feet above the level of the sea.

After crossing the stream 20 feet in width at the 77th mile, the line takes a north-westerly course and enters upon a large level plain of good clay land, completely cleared of timber by fire. After passing a small stream at the 80th mile green woods are again met with, and the line passes through a ridge of slate rock to some spruce and tamarac swamps of sandy loam, extending to the Vermilion at 82½ miles.

This crossing of the river is about eight miles above Lake Vermilion and one mile below the junction of the River Wonabing, coming in from the north-west. The width is about 150 feet and depth from 15 to 20 feet, the banks being of sand and clay, and their altitude about 970 feet above sea level.

The valley of the Vermilion is from three to four miles in width, of sandy loam, a few slate ridges protruding, and is covered by a thick growth of spruce, balsam, cedar, tamarac, poplar and small pine. Higher up, pine of good size is found. It is bounded on the west by a range of hills running north-eastward and rising to a height of 300 feet above the level of the river. Through this valley the Wonabing must pass, as, from information obtained from the Indians, it comes from a small lake about twelve miles to the north-west.

From the foregoing it will be seen that a feasible route between French and Vermilion Rivers can be obtained. The distance is estimated at 82½ miles, being an increase of 16 per cent. on a straight line between extreme points, caused by the necessary deviations and curvature.

The Wahnapetaepee was ascended into Block 47, six miles above the portage leading to Long Lake, and the country as far as could be seen from the top of the highest hills near the river, was very rough and broken by ridges of granite and gneiss from 100 to 250 feet high.

An examination was also made of the country between the south end of Long Lake and a point on a branch of the French River, north of Contin's Bay, to which Mr. Lumsden had extended his survey. This route is not favourable for railway construction, as it crosses the general course of the streams nearly at right angles, with high rocky ridges intervening.

CENTRAL DIVISION.

Lake Winnibegon to the River Aux Sables; Mr. Charles Horetsky in charge.

Lake Winnibegon was reached on the 22nd July, with canoes from Lake Huron *via* the Mississagua and other streams and lakes.

This lake, a large body of water containing numerous islands, lies between the parallels of 47° 20′ and 47° 28′ north latitude, and *nearly* upon the meridian of 83° west from Greenwich.

To the north and westward a level expanse of partially swampy country extends for many miles, its general features presenting apparently no obstacle to railway construction in the direction of the River Michipicoten.

The lack of information regarding the country south-east from Lake Winnibegon necessitated a careful and lengthy exploration before adopting the line now briefly to be described; the region to the north and east of the air-line between the "Pic" and "French" Rivers being occupied by much water area and being otherwise of a very rough character. The line now submitted begins in latitude 47° 20′ N. at a point slightly to the westward of the lower end of Lake Winnibegon, and taking a south-easterly course it crosses the River Winnibegon at a distance of five and a half miles in air-line, passing over a fairly level country of rocky formation and thickly wooded. On this portion of the line, low rocky knolls are of frequent occurrence, but the general profile will be good, seldom deviating from the average altitude of about 1,450 feet above the level of the sea.

The banks of the River Winnibegon are low (from 6 to 8 feet) level ground extending back for some distance on each side.

The width of the stream rarely exceeds 100 feet and the current is sluggish. The sinuosities of this river as shown on the plan indicate the flat character of the country from the lake outlet for many miles to the southward. The elevation at the crossing is estimated at 1,430 feet.

A distance of six and a half miles in air line now intervenes between the last named stream and the River D'Embarras, which is crossed at an elevation of 1,440 feet. Its width is trifling; the banks and adjacent grounds are low. This portion of the line was not walked over, but its features are undoubtedly similar to those west from the River Winnibegon, *i. e.*, of a low, knolly, but generally level country.

From the River D'Embarras the line takes a more southerly course to the river Cypress, on a generally level country, but rocky knolls are frequent. All this country is thickly wooded, but fire has committed great ravages.

Four miles beyond the Embarras the line touches the Cypress at an elevation of 1,422 feet. This sluggish rivulet, for many miles a mere ditch, drains Lake Wagong and Lake Moule. It is a tributary to the Epinette, a feeder of the principal stream of this region, the Mississagua.

The line now follows the Cypress for a distance of nine or ten miles to its confluence with the Epinette, where the elevation is estimated to be 1,395 feet. The Cypress follows a meandering course to the south-south-east through a nearly level region.

Granite knolls flank its course throughout nearly its entire length. The banks are low, the soil light and sandy, and a bleached forest of burnt timber stretches from Lake Wagong to the Epinette. A great portion of this section is very favourable for a railway, although the rocky formation frequently crops out upon the river, which expands about four miles below Lake Wagong into a series of lakes flanked by rocky cliffs of low elevation. All along the River Cypress the gradient is nearly level, but occasionally some rock cutting may be necessary. The country is singularly uninteresting and apparently worthless. At the confluence of the Cypress with the Epinette both streams widen out to about 20 feet, and here, only, canoe navigation becomes reasonably practicable. The country hereabouts is extremely rugged; bare granite hills from 50 to 100 feet cropping up in every direction; still, excepting for short distances, a line may be easily carried along the low banks of the river.

The confluence of the Cypress and Epinette is about twenty-six miles from the starting point near Lake Winnibegon. The River Epinette is now followed for four and a half miles in a southerly direction. The left bank, which is generally low and level, offers the best features for a line of railway.

About one mile from the confluence of the Epinette with the Mississagua, the line leaves the former, and, pursuing a south-easterly course about four and a half miles, it crosses the Mississagua. The upper part of this short section is unfavourable. The first mile of easterly ascending grade will be about 2 per 100, besides entailing in all probability a large amount of rock excavation. From the summit, however, the descent to the Mississagua will be found easy and the work medium. This summit (1482 ft.) is the highest point the line crosses since leaving Lake Winnibegon. The country thereabouts presents a most desolate appearance, its broken, rocky, surface being covered with fallen trees, burnt by frequently recurring fires.

The crossing point upon the River Mississagua (about thirty-four miles from Lake Winnibegon) is 1,422 feet above sea level; it is in latitude 46° 56′ north, and about eight or ten miles above the confluence of the Epinette.

The crossing is extremely favourable, the banks being low and level, the river bed of the finest character, and quite uniform, with an extreme width of 150 feet.

The line now enters what has been termed the Eastern River Valley. For a distance of about eight miles there is an ascending easterly gradient along a small river and chain of lakes.

Half a mile from the River Mississagua there occurs a short but steep ascent of 40 feet. Above this the gradient is very favourable until the line reaches an elevation of 1,500 feet above the sea, when a short gradient of about 2 per 100 occurs. Two miles further, another summit is passed (1,586 feet above sea) and now the line descends with sharp gradients for about a mile to the crossing of a narrow arm of Bark Lake (1,522 ft.) The section thus briefly described between River Mississagua and Bark Lake is about nine or ten miles in length, and has been thought to offer a very fair passage through the hills between the points in question. The crossing of the south-west arm of Bark Lake is about 300 feet in width, with good approaches and low banks. There is a fair depth of water, with rather soft bottom. The next and last section examined, about fourteen miles in length, has been traced on a south-easterly course through another valley, as far as the River Aux Sables to a point in latitude 46° 45′, and approximate longitude 82° 17′ west. This is about sixty miles from Lake Winnibegon.

The profile of this portion of the route is very favourable, the line following a chain of lakes to the south end of Lac Aux Sables; a small proportion of the section will require rather heavy works, but, upon the whole, this valley has been thought to offer a good passage, so far, through the rough and hilly country.

The lateness of the season put a stop to the examination of the rough, hilly country to the eastward. There yet remains a distance of about forty miles to connect with the line explored from French River.

An alternative line, cutting off a considerable portion of the line just described, has been projected upon the plan. If found feasible, the worst features of the line along the lower Epinette will be avoided, and much saving of distance effected.

The whole route from Lake Winnibegon to the River Aux Sables appears to offer a feasible line for the railway, with very favourable gradients, and an average of medium work throughout.

It deviates very considerably from the direct line between the Rivers French and Pic; Lac Aux Sables being estimated about seventeen miles to the south-west of that line. Explorations have been made in connection with the line described by two different chains of lakes to points north of the direct line, but the country was found so unfavourable as to give no promise of a practicable line for the railway.

WESTERN DIVISION.

From River Pic to Lake Winnibegon; J. L. P O'Hanly in charge.

For convenience of reference the division may be subdivided into two sections. One comprising that part of the exploration east of the River Michipicoten, and the other, that to the west.

The western section which extends from Lake Superior eastward to the Michipicoten is, by rough computation, 95 miles long. This is probably 10 per cent in excess of an air line. The first serious engineering difficulty encountered in this section is in rising to the summit which divides the waters of Sand Beach from the Minguish, both important branches of White River, where an ascent is met with of 400 feet in two miles, between the 31st and 33rd mile, attaining a maximum elevation of about 1,200 feet above the level of Lake Superior, or 1,800 feet above the level of the sea. There are indications that this ridge extends in a westerly direction from the Minguish to Lake Superior, and that there is no more favourable crossing for a long distance on either side.

The crossing of what seems to correspond to the same ridge by the exploration of 1875, nearer Lake Superior, was less favourable.

The country thence to the River Doré at 74 miles, is rolling, and in many places broken, rugged and difficult, but with long stretches of a more favourable country intervening. The altitudes above sea level, at the following points, are given approximately.

River Minguish (39 miles), 1,400 feet; Lake Minguish, (45 miles), 1,450 feet; on the divide at 46 miles, 1,700 feet; River Puckaswa (54 miles), 1,400 feet; Dog River (60 miles), 1,100 feet; Gull Lake (66 miles), 1,100 feet; River Doré (76 miles), 1,025 feet.

The route from the Doré to the Magpie and thence to the Michipicoten is of a very difficult character, although a more thorough examination may establish a feasible line. The altitude at the crossing of the Michipicoten is estimated 940 feet above sea level.

The country traversed is barren, rocky and broken. The surface for fully two-thirds of the distance is composed of rock generally bare of mould. The formation is amorphous, being composed chiefly of greenstone, trap, &c. The timber consists principally of spruce, intermixed with balsam, tamarac, white birch, poplar and cypress; none of the varieties indigenous to the latitude of Ottawa were seen, except some black birch in the immediate neighbourhood of the Michipicoten; white and red pine are unknown until the Michipicoten is reached.

The eastern section extends from the Michipicoten to Lake Winnibegon, a distance ot about 75 miles.

The course from this point is across the Michipicoten, at the foot of the White Fish Lake, and skirting along the base of a hill to the first crossing of the Shequamka or east branch of the Michipicoten, near the 100th mile; altitude 1,000 feet.

On the east of the Shequamka, a level brulé or pitch pine plain is found about three miles long. Beyond this, the ground gradually and steadily rises, forming a kind of promontory, around which the Shequamka flows. This portion of the line is difficult; the altitude of the highest point, near 106th mile, is 1,735 feet above sea level.

From the second crossing of the Shequamka, 110th mile, to the plain of the River Montreal, the surface is undulating, but presents no engineering difficulties, as the hills are detached or isolated, and can in every case be easily avoided by curvature; altitude from 1,400 to 1,700 feet.

From the Montreal eastward to the extremity of the exploration the country is exceedingly favourable for easy gradients. It is nearly level, having all the appearance of an extinct lake. Standing on a clay hummock in a brulé, an unbroken horizon, particularly toward the north, is seen. The Winnibegon Indians

informed us that a short distance north of where we met them, the water flowed in the opposite (Arctic) direction, these swampy plains evidently forming the plateau of the height of land. The altitude at River Montreal, 121 miles, is 1,420 feet; between that and Deepwater Lake, 133rd mile, it ranges from 1,600 to 1,400 feet. Thence to Winnibegon Lake, 161st mile, it is nearly a dead level, 1,400 feet above the sea.

On this section there were considerable tracts of land passed over, particularly east of the River Montreal (on the out-flanks of the swamps), well fit for settlement. The swamps are in every stage of formation, from a semi-fluid state, covered with wild grass and stunted spruce and tâmarac, to a well-developed alluvium. The proportion of rock is much less than on the western section, and is but rarely met east of the Montreal, and then only in detached, low hills.

The timber is principally spruce and tamarac, intermixed here and there with groves of white and red pine, mostly burnt, and balsam, with poplar, birch and soft maple on the ridges. A great deal of the country has been burnt over.

It is probable that a much better route would be found on the Western Division, without materially increasing the distance, by carrying the line ten to twelve miles further north, turning off from the present exploration at the second crossing of the Shequamka and following its course westward for some distance, thence towards the Michipicoten, crossing it at the foot of Lake Manoutawak; thence to the River Magpie, at or near the intersection of Herrick's line; thence west to Dog Lake the source of Dog River; thence to the source of White River and along the valley of the same to the foot of Lake Nettamissogany, and from thence directly across the watershed to the rivers Black and Pic, or down White River to connect with the present exploration.

The advantages of the proposed change seem to be that instead of crossing the numerous streams flowing into Lake Superior in deep valleys, involving steep gradients, heavy bridging and other works, its proper direction will be in rear of their sources, intersecting only two of them, the Magpie and the Michipicoten, and that at considerably increased distances from their mouths. By this means, the Doré, Bear, Pucasquaw̄ and Gull rivers with their many branches would be entirely avoided, as well as some of the most difficult country. The uninterrupted distance between the valley of the Magpie and the sources of the Dog River, may reasonably be presumed to be more favourable than that hitherto traversed with the intervening depressions of the streams. It also appears that Herrick's line crosses the Magpie at a favourable place.

In the exploration made near to the coast in 1875, the most difficult part of the route between the rivers Pic and Michipicoten was found to be a high ridge dividing the waters of the Bear from those of the Doré, called Burnt Plain Mountain, extending to Lake Superior. The present exploration having passed in rear of the sources of Bear River, this obstruction was avoided altogether.

In 1875 the White River from its mouth to the confluence of the Minguish was explored, and no serious difficulty was observed along its valley. The greatest objection to following it down from the foot of Lake Nettamissogany is the increased distance.

The results of these explorations shew that a line from French to Vermilion River, 80 miles, can be obtained with good gradients, and generally without very heavy works.

Between the rivers Vermilion and Aux Sables, roughly estimated 40 miles, the country has not been explored; what is known of it is rocky and broken. But as the Spanish river has its source there, it is probable that some of its branches or tributaries may afford a feasible route.

From the River Aux Sables westward—60 miles—to Lake Winnibegon, the country is, on the whole, not unfavourable; on the first 30 miles to the crossing of the Mississagua there will be some short lengths of rather stiff gradients, and some rocky spurs to be cut through. On the balance, the profile is more uniform, the altitude being about 1,400 feet above the level of the sea, with very little variation.

From Lake Winnibegon westward to the Shequamka, 60 miles, the same altitude is maintained with remarkable uniformity, and on the first half, the works will be light; on the balance, the country is undulating but not difficult.

From the River Shequamka to the River Pic, Lake Superior, the distance on a direct line is estimated 110 miles. On a great portion of this, the country is very unfavourable; it is intersected with streams crossing the line and forming deep valleys with high rocky ridges intervening. In some places, these appear impracticable for a line of railway with ordinary gradients. It is probable, however, that a better line may be found by following the Pic some distance further inland.

Trial Location Survey, from Contin's Bay, French River, to Lac Amable du Fond, the proposed Eastern Terminus.—Mr. Hugh D. Lumsden, in charge.

This line commences at Contin's Bay, on the south arm of French River, about twenty miles from its mouth, and terminates about a quarter of a mile south-west of the western extremity of Lac Amable du Fond; its length is 80 miles.

The line takes a south-easterly course up the valley of a small stream for 2½ miles, then it bends sharply to the north-east, and at the fifth mile again touches the margin of a bay of French River, which it follows two miles to the mouth of the Pickerel.

On the first five miles the works will be light, but on the sixth mile there will be a considerable amount of rock excavation.

From Contin s Bay to this point, the French, together with a projecting bay, forms a broad sheet of deep still water, with the exception of about 2,000 feet in length, in which the water is only ten feet deep, on a bar of mud and sand; if this were dredged, so that it could be utilized for navigation, the first six miles of the line surveyed for the railway would not be required. The altitude at the sixth mile is approximately 596 feet above the level of the sea; from that point the line takes a course nearly due east, up to the twenty-second mile, where it enters the valley of Wolf River. The gradients up to 9½ miles are all rising eastward, two of them at the rate of 1 per 100, making together a mile and a quarter in length; on the rest of the distance they are undulating; the highest rising eastward is .90 per 100 for three quarters of a mile; there are three lengths rising westward, making an aggregate of three quarters of a mile.

Thence the line follows up the valley of Wolf River, on the same general course, but with more curvature in detail, to the 39th mile, with very easy gradients; the only exceptions being two short lengths of 1 per 100, the one rising eastward and the other westward.

The works up to this point will generally be moderate, although the cuttings will be nearly all in rock; they are very short, and few of them reach ten feet in maximum depth, except between the 26th and 27th, the 32nd and 33rd, the 37th and 39th miles, where the rock excavations will be heavy, some of them having a maximum depth of about 30 feet.

At 18½ miles the Pickerel is crossed, 140 feet in width, with a depth of 13 feet in mid-channel.

The Wolf River is crossed five times, requiring bridging 60 to 100 feet in length at each crossing, and at several places it will have to be diverted.

From the 39th mile the course of the line is more tortuous, and its general bearing is a little to the south of east. At 38¾ miles the altitude is 735 feet; thence the rise eastwards is almost continuous to the 48th mile, where the altitude is 1,072 feet. On this section there are three lengths of a gradient of 1 per 100, making together four and a half miles, and two miles of ·75 to ·80 per 100.

The works on this section will be heavy, chiefly rock cuttings, with a ravine to be crossed at the 41st mile, 1,500 feet wide and 75 feet maximum depth.

The line crosses the Nipissing colonization road between the 48th and 49th mile. Thence to the 53rd mile the gradients are easy and undulating. The works on the first three miles will be light and moderate; on the balance they will be rather heavy.

At 51½ miles Commando Creek, 60 feet wide, is crossed.

From the 53rd mile there is a gradient of 1 per 100 rising eastward a mile and three-quarters on a rocky side hill, and the works will be heavy.

Near the 55th mile is the divide between the waters falling south-westward into the River Magnetawan, and north-westward into French River; the altitude is 1,208 feet above sea level.

From the 55th mile the general course of the line is nearly east to Lake Conchies, near the 67th mile. The gradients are undulating and generally easy, with the exception of one length of 1 per 100 rising eastward a little over half a mile, and a similar gradient rising westward about a mile in length.

On the first three miles the works will be light, on the next four miles they will average heavy, and on the balance they will be very light.

Between the 66th and 67th mile the South River is crossed twice. Each crossing will require a bridge of 100 feet span.

From the 67th to 76th mile the line follows up the valley of South River on a general course, a little to the east of north, with very easy gradients, and the works will be light, except on one mile, near the 75th, where they will be rather heavy.

The South River, in this section, is crossed three times—one crossing being 60 feet wide, and the others 40 feet each.

At the 76th mile the waters flow westward into Lake Nipissing, and eastwards into the River Ottawa; altitude, 1,231 feet.

From the last point the line takes a course nearly east to the end at the 80th mile, with very easy gradients. The highest point on the line is 1,240 feet above sea level, at $77\frac{1}{2}$ miles; the altitude at the 80th mile is 1,230 feet.

On three miles of this the works will be light, and on the balance moderate.

The River Amable du Fond is crossed twice, requiring a bridge of 40 feet span at one crossing, and 100 feet at the other.

From the commencement of the line at French River to the 48th mile, the country is generally rocky, with very little soil fit for cultivation. Eastward of that the country improves, but is much broken with rocky ridges.

Line to the Chaudière Falls, French River.

Explorations were made for a route to connect this last line described with that explored from the Chaudière Falls westward. The only feasible line that was found takes a general course from the crossing at the Falls, varying from south-east to south, and intersects the located line at 34 miles from French River. Its length is about 13 miles, over a rough and broken country, especially in the first six miles from the Falls, on which the works would be heavy.

DESCRIPTION OF THE GENERAL ENGINEERING FEATURES OF THE LINE FROM LAKE SUPERIOR TO THE YELLOW-HEAD PASS IN THE ROCKY MOUNTAINS.

First Division.—From Lake Superior to Red River, 410 *miles.*

The line commences on the left bank of the River Kaministiquia, a little over two miles from its entrance into Thunder Bay, and takes a general course about North 60° West to Lake Wabigoon, 208 miles; thence to Cross Lake, 334 miles, it is nearly due west, but there is a great deal of curvature in detail.

The country up to this point is generally of the Huronian and Laurentian formations, in irregular bands, and the character and extent of the soil varies accordingly. The best section is on the watershed to Lake Superior, which is rolling and well-timbered, principally with tamarac and spruce, interspersed with birch, poplar, balsam, cedar and a few pine. The tamarac has supplied excellent railway ties, and there is a considerable extent of good land in the valleys, and patches on the hill-sides fit for cultivation.

Advancing westwards, the country is more broken with rocky hills, lakes and swamps, and the proportion of land fit for cultivation decreases. There are patches of tamarac and spruce with an increased proportion of pitch pine and other woods of fair size on the low ground, but, generally, on the hills, it is of smaller growth.

On the last 70 miles, up to Cross Lake, the country is composed almost entirely of granitic and gneissoid rocks; it is very rough and broken, with numerous lakes and swamps, and there is scarcely any soil fit for cultivation; there are, however, patches of good tamarac, spruce and pitch pine, interspersed with birch, poplar and balsam.

From Cross Lake to Red River is on the alluvial basin, where the prairie region commences, and the soil is very rich. The general course of the line for this section is about N. 75°, west.

Section 1.—*Fort William to Sunshine Creek*, 32½ *miles.*

This is contract No. 13, the works of which are nearly completed, and the rails are laid for 25 miles.

Commencing at a point on the north bank of the River Kaministiquia, 604 feet above the level of the sea,* the line takes a north-west course, gradually leaving the valley, to cut off a great bend, with continually ascending gradients to 15½ miles, at which it attains an altitude of 1,077 feet. In this rise there are five lengths, making an aggregate of a little over six miles, of a maximum gradient of 1 per 100=5,280 feet per mile. Thence, with undulating gradients, the line re-enters the Kaministiquia valley, and crosses the river between the 23rd and 24th miles, near its confluence with the Mattawan, altitude 1,010 feet. In this length there are three-quarters of a mile of maximum gradient of 1 per 100, rising westward, and nearly five miles of a maximum of ·50 per 100 rising eastward.

The line then follows the south bank of the Mattawan nearly to the 28th mile, when it crosses the river, and follows up the valley of Sunshine Creek to the end of the Section, at 32½ miles, with generally ascending gradients.

On the first twenty miles the works are light; on the balance they are a little heavier, but still very moderate; there is some rock cutting at the crossing of the River Kaministiquia. The principal structures are:—

At 5¼ miles—A trestle bridge across a ravine, 300 feet wide at the top, 100 feet at bottom, and 40 feet deep.

At 23¼ miles—The Kaministiquia is bridged with two spans of Howe truss, 100 feet each.

27½ miles—The Mattawan is crossed with one span of 100 feet, Howe truss-bridge.

29 miles—Sunshine Creek is bridged with one span of 80 feet.

Section 2.—*Sunshine Creek to English River*, 32½ *miles to* 113 *miles.*

This Section was put under contract (No. 25) in June, 1876, and the grading on the first half of it has been vigorously prosecuted. The line follows up the valley of Sunshine Creek to the 39th mile, then it crosses a narrow divide to the valley of the Oscondigé, which it follows up to the height of land near the 53rd mile. From this it follows the valley of the Savanne to the 71st mile, crossing the river about two miles from Lac des Mille Lacs, to which it is navigable for vessels of light draught. Thence it traverses a slightly undulating and easy country to Hay Lake, at the 90th mile, crossing a bay of Firesteel River at 93½ miles, and English River at 111 miles, within two miles of its outflow from Hawk Lake. The gradients are undulating and generally easy; there are several short lengths of the maximum of 1 per 100, rising westward, making together about five miles. The aggregate of the maximum gradients (26·40 per mile) rising eastward, is about 10½ miles.

The altitude at 53 miles is 1,581 feet; this is on the "height of land" which separates the waters flowing southward into Lake Superior, and westward into Lac des Mille Lacs. At English River the altitude is 1,513 feet.

The works up to 41½ miles will average rather heavy, some of the embankments running up to thirty feet in height, and the cuttings to twenty feet in depth, some of

*This datum of sea level will be understood throughout, wherever the altitude is given.

them in rock; these, however, are generally in short lengths. From this to the end of the Section they will be very moderate on the average, for the cuttings are generally shallow; but as many of them are in rock, the following classification will be better:---26 miles medium or moderate, 45 miles very light works.

The principal structures are:---

At 40½ miles---River Oscondigé; one span of 80 feet.
47¼ miles---River Oscondigé; second crossing, five spans of 20 feet.
71¼ miles---River Savanne; pile bridge, 8 spans of 20 feet.
90 miles---Bay of Hay Lake; Howe truss bridge, one span of 100 feet.
93½ miles---Firesteel River; Howe truss, one span of 100 feet.
97 miles---Beaver River; pile bridge, four spans of 20 feet.
100½ miles—Fox River; pile bridge, three spans of 20 feet.
111 miles---English River; pile bridge, fourteen spans of 20 feet.
112½ miles---Scott's River; pile bridge, nine spans of 20 feet.

Section 3---*English River to the head waters of the Little Wabigoon River*, 113 *to* 160 *miles.*

This section of the line is across a rolling country, containing numerous lakes and swamps with very irregular rocky ridges, bearing generally in a north-east direction, almost at right angles to the course of the line. Taking advantage of the narrow valleys and basins of low land, and depressions in the rocky ridges, a line has been obtained with tolerably easy gradients, and without heavy works. The gradients are undulating, the highest point reached is at 120 miles, where the altitude is 1,558 feet; the lowest points are at 154½ and 160 miles, altitude 1,408 feet.

There are 1¾ miles of the maximum gradient of one per 100, rising westwards; three miles of ·50 per 100, and 7¾ miles of ·60 to ·75 per 100 rising eastwards, but it is expected that the location can be improved so that all these can be reduced to a maximum of ·50 per 100=26·40 feet per mile, without greatly increasing the cost of the works.

The works will be moderate on the average; very few of the line cuttings will exceed 1,200 feet in length or 20 feet at their greatest depth, and these generally will be in sand and clay mixed with boulders, but solid rock may be expected in the bottom of many of the cuttings.

There will be no heavy structures on this section; the longest will be at the two crossings of the River Osaquan, 153 and 154 miles, requiring a 30 feet opening for waterway at each. The River Ah-gim-ack, at 147 miles, will require a clear waterway of 25 feet.

Section 4.---*From the head waters of the Little Wabigoon River to Thunder Lake*, 160 *to* 206 *miles.*

The line follows generally parallel to the valley of the Little Wabigoon, nearly due west to the east shore of Lake Wabigoon, which from this point, bears north for about three miles, and then bends to the west. The course of the line is generally parallel with it, to the end of the section, at a point on the narrow neck that separates Thunder Lake, from Lake Wabigoon.

On this section the general fall is westward; the altitude at 160 miles being 1,408 feet, and at 206 miles it is 1,215 feet; but there a few undulations giving maximum gradients of 1 per 100 for 3½ miles, rising westward with three miles of ·50 per 100, and 15½ miles from ·60 to ·75 per 100 rising eastward; the latter will be reduced in locating the line for construction.

The excavations, on this section will generally be neither long nor deep, but they will be in great part in rock. They will, on the average, be moderate, but a little heavier than on the last section.

The principal structures will be;---

At 176½ miles---Little Wabigoon River, three spans of 40 feet.
203½ miles---Blackwater Creek, 30 feet opening.
204 miles---Thunder Creek, 40 feet opening.

Section 5.---*Thunder Lake to Lake Feist*, 206 *to* 264 *miles.*

This section is over a heavily rolling country, with numerous lakes, swamps and rocky hills, and some good land interspersed. The altitude at the beginning (206 miles) is 1,215 feet; at 228 miles it is 1,152 feet; at 259 miles, 1,391 feet; and at the end of the section, 264 miles, it is 1,347 feet. There are 6½ miles of gradients of one per 100 rising westward; 5¼ miles of ·50 per 100, and 9 miles of ·60 to ·75 per 100 rising eastwards; the latter will be improved by a re-survey.

The works up to 244 miles will be moderate ; there is but a small proportion of rock in the cuttings. But on the balance of 20 miles they will be nearly all in rock, and, in alternate lengths, will be heavy and medium. On the whole section the works may be classed :—10 miles of heavy works, and the balance, moderate or medium.

The principal structures will be:—

At 214¼ miles---River Wabigoon, two spans of 80 feet.
219½ miles---River Shashagawae, one of 20 feet.
221½ miles---River Shashagawae, second crossing, one of 30 feet.
231½ miles---Eagle River, one span of 80 feet.
254½ miles---ravine, 400 feet across, 40 feet deep.
260 miles---arm of lake, one span of 50 feet.

Section 6.---*Lake Feist to Rat Portage on the River Winnipeg, at the outlet of the Lake of the Woods*, 264 *to* 298 *miles.*

This section is over a very rough, rocky country, indented with numerous lakes and hollows, and containing very little soil. The gradients fall westward with few exceptions, there being only a mile and a quarter of one per 100 rising in that direction. Of the maximum rising eastwards, there are four miles of ·50 per 100, and eight miles of ·60 to ·75 per 100.

On 24 miles the rock excavations will be heavy ; on the balance of nine miles they will be moderate.

The principal structures will be :—

Bridging the River Winnipeg; one clear span of 200 feet.

At four different streams : bridging with one clear opening of 20 feet for waterway. Four tunnels, six feet diameter, and two, eight feet diameter, under railway, through rock, for waterway.

Section 7.—*River Winnipeg* (*Rat Portage*) *to Cross Lake*—298 *to* 334 *miles.*

This section was put under contract (No. 15) for construction, in January last ; it is similar in character to the last section, rocky and broken, but the gradients are better; the altitude of formation level at the second crossing of the River Winnipeg is 1,092 feet, and at Cross Lake, the end of the section, it is 1,088 feet. There is only one mile of the maximum gradient of 1 per 100, rising westward, and a little over four miles of the maximum of .50 per 100 rising eastward.

The excavations will be, for the greater part, in rock, including a tunnel 500 feet in length, and the works may be classed :—30 miles heavy, and six miles moderate.

The principal bridging will be at the second crossing of the River Winnipeg, 298¼ miles, where one clear span of 200 feet, for waterway, will be required. At other points, tunnels will be cut in rock, under the railway, to pass the water through, instead of bridging; one of these will be 20 feet diameter; two of 16 feet; one of 12 feet; and eight of them from 6 to 8 feet diameter.

Section 8.—Cross Lake to Red River,—334 to 410 miles.

This section was put under contract (No. 14) in April 1875, and the works are well advanced; the track-laying is embraced in Contract No 15, and is not yet commenced.

The country is composed of alluvial soil, bearing tamarac, spruce, poplar, prince's pine, &c., with intervals of prairie, and muskeg, or swamp. The trees are very small towards the west end of the section.

The gradients are easy and generally falling westward; there are six miles of a maximum of ·50 per 100 rising eastwards. The altitude at 410 miles near Red River is 744 feet.

The excavations on the first mile will be heavy; nearly all the rest of the section is a low embankment, made from side ditches, but there are a number of offtake drains, some of them of considerable length and depth.

The principal bridging is at:—

368 miles—River Whitemouth; two spans of 100 feet.
369½ " —Beaver Creek; one span of 80 feet.
391 " —River Brokenhead; one span of 100 feet.
409½ " —Creek; one span of 80 feet.

On the whole of this division—410 miles—there are about 70 miles on which the rock excavations will be heavy, one half of which are in the sections under contract; on the balance, about one third will be light work, and the rest moderate or medium.

A re-survey and location of the most difficult portions of the line between the English and Winnipeg Rivers would probably reduce the maximum gradient rising eastwards to ·50 per 100 = 26·40 feet per mile, without greatly increasing the cost of construction.

SECOND DIVISION.—RED RIVER TO BATTLEFORD, 410 TO 967 MILES.

Section 1.—Red River to Northcote at the North end of Duck Mountains, 410 *to* 629 *miles.*

From the crossing of Red River at Selkirk, the line follows an almost direct north-westerly course to Northcote, at the north end of the Duck Mountains.

The country traversed may be described as a gently undulating plain, a considerable portion of which is open prairie, with belts and groves, chiefly of small poplar, increasing in size as the Duck Mountains are approached, interspersed with small marshes and lakes; there are four of these marshes from one to three miles wide, and generally two to four feet deep to hard bottom, the rest are small.

Shoal Lake is reached at 455 miles; Dog Lake at 504 miles; the narrows of Lake Manitoba at 517 miles; south end of Lake Winnipegoosis at 573 miles, and Mossy River at 580½ miles.

At Red River the altitude of the line at formation level is 744 feet; at Shoal Lake, 866 feet; at Dog Lake, 825 feet; at the narrows of Lake Manitoba, 828 feet; at Mossy River, 845 feet; at Duck River, 1,190 feet, and at Northcote—629 miles—it is 1,180 feet.

The gradients are very easy, generally from five to ten feet per mile; the maximum rising eastward is 26·40 feet per mile which occurs only in a few short lengths; the maximum rising westward is 52·80 feet per mile, but there is only about a mile of it in this section.

The works will be very light; nearly the whole length will be low embankments made up from side ditches.

The principal bridging will be—

At Red River waterway, 800 feet wide, 20 feet deep.

The narrows of Lake Manitoba, 2,600 feet wide, sloping very gradually from each side to a depth of 15 feet in the centre; this will be crossed with pile bridging and embankment.

Mossy River—Waterway; 100 feet wide.

Duck River—Waterway; 60 feet wide.

From Northcote the line takes a south-westerly direction up the valley of Swan River to Livingstone—677 miles—about eight miles north of Fort Pelly; thence it keeps a course a little to the north-west in almost a direct line to Caerlaverock, 912 miles, at the elbow of the North Saskatchewan. From that point it follows the valley of the Saskatchewan on a general north-west course to Battleford, at 967 miles. From 629 to 654 miles the country is wooded; 654 to 683 miles the woods are in belts and patches with intervening stretches of prairie; 683 to 710 miles is wooded. Up to this point the prevailing wood is spruce of good size and quality, mixed with tamarac, poplar and birch of small size, some of the tamarac is large enough for railway ties. Between 710 and 820 miles there are belts and groves of poplar and willow, and occasionally open prairies; thence to Caerlaverock, 912th mile, it is open prairie with very little wood on either side of the line. Thence to Battleford in the valley of the North Saskatchewan, it is chiefly small poplar, with an interval of open prairie between the 932nd and 946th mile.

Section 2.—*Northcote to Stopford,* 629 *to* 729 *miles.*

The gradients rise generally westward, with some undulations, to the highest point on the plateau at 729 miles, where the altitude is 2,019 feet. The maximum is 1 per 100, rising westward, of which there is an aggregate length of 7½ miles on this section. Rising eastward the maximum is ·50 per 100, of which there are 18 short lengths, making an aggregate of nine miles.

The works on this section will be moderate on the average, but heavier than on the preceding, owing to a great number of narrow deep vallies or coulés to be crossed with bridging or embankment, of which there are eight, varying from 700 to 2,000 feet wide, and 30 to 90 feet deep; also the valley of the east branch of the Assiniboine River, which is 2,800 feet wide, and 80 feet deep.

The principal streams to be bridged are :—

At 641	miles	......Stream..............................	60	feet opening.
650	"	......Rolling River	60	"
658	"	......Stream	40	"
665	"	...... "	40	"
675½	"	...... "	40	"
682	"	...... "	40	"
707	"	...... "	30	"
711	"	......East branch of the Assiniboine.	100	"
721	"	......Stream..............................	30	"
718½	"	......South branch of the Assiniboine..........................	100	"

Section 3.—*Stopford to Denholm,*—729 *to* 831 *miles.*

On this section the gradients are easy and undulating, but the general fall is to the west; there is only one mile of the maximum gradient of 1 per 100, rising in that direction, and an aggregate of 13 miles, in a number of short lengths, of ·50 per 100 rising eastward.

The earthworks will be very light throughout, and the largest structure will be over a stream 30 feet wide.

Section 4.—*Denholm to Caerlaverock,* 831 *to* 912 *miles.*

The altitude at Denholm is 1,856 feet, and at Caerlaverock 1,542 feet, so that the fall is generally westward, and the gradients in that direction are very easy. Rising

eastward from the valley of the South Saskatchewan there is a gradient of ·80 per 100 a mile in length, and one of 1 per 100, three-quarters of a mile in length. The maximum on the rest of the section rising eastward is ·50 per 100, of which there are a number of lengths varying from half a mile to a mile and three quarters, making an aggregate of nearly 17 miles.

The earthworks on the first 18 miles will be heavier than on the preceding Section. There are a number of sharp undulations or ridges with narrow valleys intervening, requiring embankments from 1,000 feet to 2,000 feet in length, and varying from 10 to 25 feet in maximum depth; these become gradually lighter as we proceed westward to the valley of the South Saskatchewan, at 878 miles; this is 1,600 feet wide and 88 feet deep. Thence, to the end of the Section, the works will be very light.

There will be only one large structure on this Section, at the crossing of the South Saskatchewan, which will require a clear water way of 1,000 feet.

Section 5.—*Caerlaverock to Battleford*, 912 *to* 967 *miles.*

The line skirts the base of the Eagle Hills, by which it is forced close to the bank of the North Saskatchewan, which it follows to the end of the Section at Battleford.

The altitude at Caerlaverock is 1,542 feet, and at Battleford, it is 1,615 feet. The gradients are undulating, but generally easy, there being a length of a mile and three quarters of the maximum of 1 per 100, rising westward, and there is an aggregate length of a little over seven miles of ·50 per 100, rising eastward.

The earthworks will be rather heavy, as there are a number of coulés to be crossed that have been worn out of the alluvial soil by the lateral streams. The valley of Battle River is 2,600 feet wide and 50 feet deep. Eagle Hill valley is 2,300 feet wide, by 44 feet deep, and there are seven others, varying from 500 to 1,200 feet in width, and 40 to 70 feet in depth.

The principal bridging will be at—

918 miles—	Eagle River,	a clear opening of	80 feet
923 "	Stream,	"	80 "
953 "	"	"	30 "
956 "	"	"	60 "
964½ "	Battle River, water way		400 "

The works on the whole of this division of 557 miles will be very moderate on the average; the heaviest excavations can be considerably reduced, and some of the worst gradients improved, in locating the line for construction.

THIRD DIVISION.—BATTLEFORD TO YELLOWHEAD PASS, 967 TO 1,453 MILES.

Section 1.—*Battleford to Edmonton* (19 *miles south of the Fort*), 967 *to* 1,197 *miles.*

At Battleford the line leaves the valley of the North Saskatchewan and follows that of Battle River, in a generally north-west direction, to the west end of the Willow Hills, at 1,027 miles; thence the general direction is nearer to west, across a rolling and somewhat hilly country to Edmonton, about 19 miles south of the Hudson's Bay Company's fort.

The rise is generally westwards, attaining the highest altitude, 2,555 feet, at the 1,179th mile, from which point the descent is gradual as the line approaches the valley of the North Saskatchewan. The altitude at Edmonton is 2,413 feet.

The gradients are generally easy; the aggregate of the maximum of 1 per 100 rising westward is 14¼ miles.

Rising eastward,	1.00	per 100,	7¼	miles.
do	·70	do	1½	do
do	·60 to ·50	do	14¼	do
do	·50	do	8½	do

These are scattered throughout the section in short lengths.

Between the 1,074th and 1,037th miles the excavations in earth will be heavy, and on the balance they vary in alternate lengths from light to medium or moderately heavy. On the whole section the excavations may be classified thus:—

13	miles	very heavy,
49	do	moderately heavy or medium.
70	do	very moderate.
98	do	light,
230		

On the first hundred miles the bridging will be very light, chiefly on small streams, but beyond that there will be some very heavy structures, viz.:—

At 1,074½ miles, coulé, 1,100 feet wide at the top, 100 feet at bottom, and 65 feet deep.

At 1,077½ miles, Grizzly Bear Creek valley, 2,200 feet wide at top. 1,000 feet at bottom, by 155 feet deep.

At 1,101 miles, Buffalo Coulé, 1,600 feet wide at top, 700 feet at bottom, by 100 feet deep.

At 1,192 miles, White Mud Coulé, 3,000 feet wide at top, 1,400 feet at bottom, by 95 feet deep.

The greater portion of this section is wooded with small poplar and willow, with openings at intervals; the hills are generally covered with poplar. The first eight miles on the line west of Battleford is prairie; from 1,032 miles to 1,074 miles, and from 1,124 to 1,133 miles, is also prairie.

*Section 2—Edmonton to the River Pembina—*1,197 *to* 1,267 *miles.*

From Edmonton the line takes a course nearly due west for 14 miles; thence to the Pembina the general course is more to the north-west, but with a considerable amount of curvature in detail. It crosses the North Saskatchewan at 1,218 miles, and runs generally parallel to that valley, on the north side of it, to 1,235 miles, opposite White Earth Fort. Thence to the Pembina the country is hilly and rolling, and dotted with numerous small lakes. The line follows the south shore of White Lake, which is about nine miles long and two to three miles wide, and crosses the River Pembina at 1,267 miles.

The country is generally wooded with poplar, spruce, pitch pine, tamarac and birch. The spruce is of good size and quality, and some of the tamarac is large enough for railway ties.

The altitude at Edmonton, 1,197 miles, is 2,413 feet, and at 1,211 miles it is 2,377 feet; the gradients between these points are very easy, the maximum being ·62 per 100; thence the descent to the Saskatchewan is continuous, the altitude at the crossing, 1,217½ miles, being 2,200 feet.

From this point the rise is generally westward to 1,226 miles, where the altitude is 2,490 feet; thence to the Pembina the difference of level is not great; at 1,237 miles the altitude is 2,348 feet; at 1,256 miles, is 2,427; at 1,264 miles, on the summit of the "divide," it is 2,518 feet, and at the crossing of the Pembina, 2,410 feet.

From the 1,215 miles to the end of the section the maximum gradient is 1 per 100 of which there is an aggregate length of a little over nine miles rising westward, and five and a half rising eastward.

On the first 18 miles from Edmonton the works will be very light, but both the excavation and bridging will be heavy in crossing the valleys of the North Saskatchewan and Pembina.

On the whole section the excavations may be classified thus: 29 miles heavy, 9 miles medium, and 32 miles light.

The principal bridging will be at:—

1,210	miles—	Stream, 30 feet opening.
1,217½	do	North Saskatchewan: Valley 2,100 feet wide at top, 1,200 feet at bottom, and 104 feet deep; waterway at flood 1,100 feet wide by 26 feet deep.
1,222	do	Coulé—900 feet wide at top, sloping to 30 feet at bottom, clear waterway 30 feet.
1,237	do	White Lake Creek 550 feet wide at top, 40 feet at bottom, with clear waterway of 40 feet.
1,244½	do	Bay of White Lake, 40 feet opening.
1,254½	do	Stream, 40 feet opening
1,261½	do	River Sturgeon, 60 feet opening.
1,266	do	Stream 40 " "
1,267	do	River Pembina, bridging 1,000 feet by 80 feet deep, water at flood, 300 feet wide by 20 feet deep.

Section 3.—*From the River Pembina to the Athabasca,* 1,267 *to* 1,373 *miles.*

After crossing the Pembina, the line follows up the valley of the Lobstick to the Lake, which is an expansion of the river, at 1,281 miles; it then keeps on the south side of the valley to 1,301½ miles, where it crosses the river, and takes a westward course across a low divide to the junction of the Moose and Root Rivers at 1,308 miles, following up the valley of the latter to 1,312 miles. Thence it takes nearly a direct line west to the valley of the McLeod, which it reaches at 1,328 miles. Following the south side of this to 1,336½ miles, it then crosses the river and follows up the valley of Medicine Lodge Brook to 1,346 miles. Thence, it takes a course over a rolling country, crossing the divide between the McLeod and Athabasca at 1,357 miles, and reaching the south bank of the Athabasca at 1,373 miles.

The country in this section is wooded with spruce, pitch pine, poplar, tamarac, and birch; the spruce and poplar of good size.

At the crossing of the Pembina, the line is entering the foot hills of the Rocky Mountains, and it rises generally westward, the altitude at the Pembina, 1,267 miles, being 2,410 feet; at 1,300 miles, 2,857 feet; at 1,305 miles, 3,025 feet; at Moose River crossing, 1,308 miles, 2,901 feet; at the crossing of the McLeod, 1,336½ miles, it is 2,993 feet; at 1,357 miles, the watershed between the McLeod and the Athabasca, it is 3,486 feet; at 1,364 miles, crossing a spur, 3,571 feet; and at 1,373 miles, at the end of the section, in the Athabasca Valley, it is 3,216 feet.

Of the maximum gradient of 1 per 100 rising westward, there is an aggregate length of 20 miles. Rising eastward, there are about seven miles of gradients varying from ·90 to 1 per 100.

On the first three miles from the crossing of the Pembina, the excavations will be very heavy, two of them will be in red sand stone, the first rock that has been met with west of Red River; on the rest of the section the excavations are alternately light, heavy, or medium and may be classified thus:—

24 miles heavy, 29 miles medium, and 53 miles light works.

The principal bridging will be at :—

			Feet.
1,268½	miles,	the River Lobstick, first crossing	100
1,280	do	Stream	60
1,282½	do	Stream	60
1,287	do	do	60
1,293	do	Crane River	60
1,297½	do	Coldwater River	60
1,301	do	River Lobstick	80
1,308	do	Moose River	60
1,310½	do	Root River	40
1,320½	do	Wolfe River	100
1,327½	do	Beaver River	80
1,333	do	Stream	80
1,336½	do	McLeod River, water way 300 feet wide, and 30 feet deep at flood; height to formation level	75
1,343	do	Medicine Lodge River ... 60 feet clear.	
1,353	do	Stream ... 60 do	
1,359	do	do ... 80 do	
1,368	do	Coulé 700 feet wide at top, sloping to a point at bottom, and 75 feet deep.	
1,371½	do	Coulé 700 feet wide at top, 250 feet at bottom, and 75ft. deep.	
1,373	do	Coulé 400 feet wide at top, 50 feet at bottom and 85 feet deep.	

Besides the above, there are, at intermediate points, four streams requiring bridges of 30 feet opening, and five requiring an opening of 40 feet.

Section 4.—*Up the Athabasca and Caledonian Valleys to the summit of Yellow Head Pass;* 1,373 *to* 1453 *miles.*

The line follows up the south-east side of the Athabasca Valley to the foot of Lac Brulé, where it crosses the Athabasca at 1,396 miles. This lake is an expansion of the river, about eight miles in length; the line follows its western shore, and, continuing on the same side of the valley, on a general south-westerly course, it reaches the foot of Jasper Lake—also an expansion of the river—near which stands Jasper House, at 1,414 miles. It then follows the northwestern shore of the lake, and continues in the same general direction up to the 1,421 miles; thence on a general course nearly south, to the confluence of the Athabasca and Myette rivers, at 1,435 miles. From this point the line follows up the Caledonian Valley on a westerly course to the summit of Yellow Head Pass, which is reached at 453 miles.

The valleys are wooded with spruce, poplar, pitch pine and tamarac of good size and quality.

The altitude of the beginning of this section—1,373 miles—is 3,216 feet; at the crossing of the Athabasca—1,396 miles—it is 3,241 feet; at 1,414 miles, near Jasper House, 3,321 feet; at the Athabasca Depôt—1,431 miles—it is 3,331 feet; and, at the summit of Yellow Head Pass, it is 3,730 feet by check levels from the Pacific coast.*

The maximum gradient is 1 per 100, of which there is an aggregate length of 8 miles rising westward, and 2½ miles rising eastward.

The excavations up to 1,403 miles will be in earth; about one-half of them will be heavy and the other light.

On the next two miles, at the head of Lac Brulé, the cuttings will be heavy, chiefly in limestone rock, including two tunnels, one of them 1,600 feet, and the other 350 feet in length. Thence to 1,413 miles the works will be light, but on the next six

*The levels carried from Lake Superior make the altitude of this point 3,720 feet.

miles, along the shores of Jasper Lake, the cuttings will mostly be in limestone, with two tunnels 250 and 225 feet in length. From 1,419 to 1,434 miles, the cuttings will be in earth, and not heavy; thence up the Caledonian Valley to the summit of the Pass, the excavations will be heavy and light alternately, some of them in gneissoid rock.

On the whole section, the works may be classed thus:—

23 miles—heavy.
25 miles—medium.
32 miles—light.

The principal streams to be bridged are at:—

1,382½ miles—Hardisty River, 100 feet opening.
1,387 " Prairie River, 100 "
1,390 " Coulé, 750 feet wide at top, 150 feet at bottom, and 60ft. deep.
1,396 " River Athabasca, 600 feet water way; from bed of river to formation level, 50 feet.
1,403 miles—Stream, 80 feet opening.
1,406 " " 60 "
1,406¼ " " 40 "
1,409 " an arm of the Athabasca, 40 feet opening.
1,413 " Mountain Assiniboine, 700 feet waterway, 20 feet below formation level.
1,422¼ miles—Stream, 40 feet opening.
1,424¾ " Snaring River, 700 feet wide; from bed of river to formation level, 18 feet.
1,425 miles—Stream, 40 feet.
1,439¾ " River Myette, 300 feet.
1,443 " Stream, 100 feet.
1,447 " River Myette, second crossing, 200 feet.
1,449 " Glen's Brook, 60 feet.
1,452 " River Myette, third crossing, 200 feet.

Three other intermediate streams, require an opening of thirty feet.

Over the whole of this Division, 486 miles, the works will average rather heavy on account of the large amount of bridging. The excavations have been classified thus:—

104 miles—heavy, partly in rock, including four tunnels of an aggregate length of 2,425 feet.
145 miles—medium.
237 miles—light.

Further examinations will be made before locating the line for construction, with the view of reducing the heaviest portion of the works, both in bridging and excavation.

A description of the general engineering features of the lines from the Yellow Head Pass to the Pacific coast will be found in Appendix T.

I have the honour to be, Sir,
Your obedient servant,
MARCUS SMITH.

SANDFORD FLEMING, Esq.,
Engineer in Chief.

APPENDIX Z (B).

CANADIAN PACIFIC RAILWAY SURVEY.

LIVES lost in connection with the Survey, during the Years 1871, 1872, 1873, 1874, 1875 and 1876.

No.	Name.	Date of Death.		Remarks.
		1871.		
1	Alexander Sinclair	August	7	Lost in forest fires.
2	William Matheson	do	7	do do
3	Indian, name unknown	do	7	do do
4	do do	do	7	do do
5	do do	do	7	do do
6	do do	do	7	do do
7	do do	do	7	do do
		1872.		
8	do do	April	7	Drowned in North Thompson,
9	Arthur Hamilton	May	20	do Lake Temiscamingue.
10	Edward J. C. Abbott	do	20	do do
11	George Knout	do	20	do do
12	George Rochette	do	20	do do
13	Frederick Chadwick	Nov.	26	do Lake Huron.
14	William Caldwell	do	26	do do
15	—— D. Taylor	do	26	do do
16	Michael Clancy	do	13	Broke through ice.
		1873.		
17	Joseph Hughes	July	24	Drowned in Whitefish Lake
18	Arthur Torrie	do	24	do do
19	Neil Patterson	do	24	do do
20	John P. Robson	October	2	Died.
21	Nathaniel L. Price	Dec.	30	do
		1874.		
22	Wm. Tappige	October	3	Drowned in Frazer River.
		1875.		
23	John Spence	Sept.	29	do Dalles River.
24	Joe Paskall	do	29	do do
25	*Thomas Robinson	Nov.	4	Went down in steamer "Pacific."
26	*Edward Jynes	do	4	do do
27	*Samuel Nicholson	do	4	do do
28	*John Tarbut	do	4	do do
29	*George Skipper	do	4	do do
30	*Richard Corcoran	do	4	do do
		1875.		
31	W. P. Scott	Dec.	31	Died.
		1876.		
32	John Dolan	June	25	Drowned in North Thompson.
33	Isaac Howch	July	19	do Salmon River.
34	Samuel Londit	October	16	do Kettle Falls.

* These men had been paid off a few days previously.

APPENDIX Z (C).

LIST AND DESCRIPTION OF THE SEVERAL CONTRACTS ENTERED INTO IN CONNECTION WITH THE PRELIMINARY WORKS OF CONSTRUCTION OF THE CANADIAN PACIFIC RAILWAY; TOGETHER WITH THE GENERAL SPECIFICATION UNDER WHICH THE WORK IS BEING EXECUTED; ALSO INFORMATION RESPECTING ALL EXPENDITURES FOR CONSTRUCTION PURPOSES UP TO JANUARY 1ST., 1877.

CANADIAN PACIFIC RAILWAY.

SUMMARY of Payments made on Work done up to January 1st, 1877.

No. of Contract.	Name of Contractor.		Amount.
			$ cts.
1	Sifton, Glass & Co., Construction	$96,400 00	
	do Maintenance	2 519 80	98,919 80
2	Richard Fuller		98,250 00
3	F. J. Barnard		27,184 91
4	Oliver, Davidson & Co		80,680 00
5	Joseph Whitehead		208,163 00
6	Guest & Co		576,411 59
7	Ebbw Vale Steel, Iron & Coal Co		284,117 21
8	Mersey Steel and Iron Co		1,128,737 35
9	West Cumberland Iron aud Steel Co		558,175 52
10	do do		
11	Naylor, Benson & Co		265,052 36
12	The Hon. A. B. Foster		41,000 00
13	Sifton & Ward		239,220 00
14	do		214,500 00
15	Sutton, Thompson & Whitehead		....
16	Canada Central Railway Co		68,000 00
17	Anderson, Anderson & Co		51,462 96
18	Red River Transportation Co		206,171 33
19	Moses Chevrette		1,600 00
20	Merchants' and Lake and River Steamship Co		67,126 28
21	Patrick Kenny		8,782 11
22	Holcolmb & Stewart		5,850 00
23	Sifton & Ward		14,648 14
24	Oliver, Davidson & Co		3,083 70
25	Purcell & Ryan		129,100 00
26	James Isbester		14,800 00
27	Merchants' and Lake and River Steamship Co		89,060 00
28	Red River Transportation Co		....
29	Cooper, Fairman & Co		4,275 00
30	do		16,160 00
31	Patent Bolt and Nut Co		6,800 69
	Miscellaneous Payments, Inspection of Rails, Insurance, Commission, &c		218,553 06
	Engineering and Supervision of Construction		216,754 11
	Total chargeable to construction to date		4,942,739 12

(Signed) CH. O. PALMER,

Accountant.

Contract No. 1.

Telegraph.—Winnipeg to Selkirk, thence along railway line to Livingstone. Length 294 miles. Sifton, Glass & Co., contractors. The contract embraces the clearing of the land in the wooded sections to a width of 132 feet, the furnishing of all materials, labour, instruments and everything necessary to put the line in operation; the building of substantial and comfortable station-houses of log or frame, with shingle or thatch roofs, at distances not less than 50 miles apart at the most eligible points along the line; and also the maintaining and operating of the line for a period of five years after completion. Date of contract, 17th Oct., 1874; date for completion, 13th Oct, 1875.

Contract rate for forest section	$492	per mile
" prairie section	189	"
" maintenance and operating with profits, per mile per annum	16	

Paid on account of construction	$96,400 00	
" " maintenance	2,519 80	
		93,919 80

The line has been in operation for its whole length since July, 1876, but there is still some chopping and considerable burning of timber to be done.

Contract No. 2.

Telegraph.—Livingstone to Edmonton. Length 517 miles. Richard Fuller, contractor. The contract embraces the furnishing of all material, labour, instruments and everything necessary to put the line in operation, and the maintaining of the line in good working order for a period of five years after completion. Date of contract, 30th October, 1874; date for completion, 1st July, 1876.

Contract rate, erection of line	$213 18	per mile
" maintenance	$13,000 00	per annum

When the contract was entered upon it was understood that the line for its whole length would pass though a prairie country. Considerable sections of woodland, however, were met with which necessitated clearing. This was paid for at the rate of $25 per acre, by arrangement with the contractor.

Paid on account of construction.................................... $98,350 00

The line has been in operation for its whole length since July, 1876.

Contract No. 3.

Telegraph.—Edmonton to the existing telegraph system of British Columbia. Length about 550 miles. F. J. Barnard, contractor. The contract embraces the clearing of the land in wooded sections to the width of 132 feet, the furnishing of all materials, labour, instruments, and everything necessary to put the line in operation; the building of substantial and comfortable station houses of log or frame, with shingle or thatch roofs at distances of not less than thirty miles apart along the line, and also the maintaining and operating of the line (without profits) for a period of five years after completion. Date of contract, 9th November, 1874; date for completion, 2nd October, 1876.

Contract rate	$ 495 00	per mile
" for maintenance and operating, without profits	46 50	"

Paid on account of construction.................... 27,184 91

Material and supplies have been provided, but no great progress in construction has been made.

Contract No. 4.

Telegraph.—Fort William to Selkirk, about 410 miles. Messrs. Oliver, Davidson & Co., contractors. The contract embraces the furnishing of all materials, labour, instruments, and everything necessary to put the line in operation, and the maintaining of the line in good working order for a period of five years from the date of completion. Date of contract, 9th February, 1875; date for completion, 31st December, 1876.

Contract rate for	forest section	....	$ 590	per mile
"	prairie "	....	435	"
"	maintenance (included in above rates)			

Paid on account of construction	$80,680
Total amount of contract work, when completed, estimated at	243,150

The telegraph is erected 60 miles westerly from Fort William, and 50 miles easterly from Selkirk; the remaining portion is in progress.

Contract No. 5.

Pembina Branch.—From St. Boniface (opposite the City of Winnipeg) to a point on the International boundary line east of Pembina. Joseph Whitehead, contractor. Length 63 miles. The contract embraced the excavation and grading formation of the roadbed, and consisted chiefly of earthwork obtained from side ditches and borrowing pits, the roadbed being raised above the level of the prairie to a height of from twenty to forty inches, as circumstances required. At all stream crossings, openings were left in the roadway for such structures as were considered necessary. The structures are unimportant and are not yet in place. Date of contract, 30th August, 1874; date for completion, 30th October, 1875.

Contract rate, 22 cts. per cubic yard, with an additional allowance of *one* cent per cubic yard for every hundred feet of haul over and above 400 feet. Amount paid on the completion of the contract $208,163.00.

Contract No. 6.

Rails.—For 10,000 tons of Bessemer steel rails, with the proportionate quantity of fish-plates, bolts and nuts, to be delivered at Montreal, Guest & Co., Manufacturers. The specification required the rails to be 57¼ lbs per yard or 90 tons per mile of railway, the rails to be fish-jointed with Bessemer steel fish-plates and iron bolts and nuts, the form of rail to be "Sandberg's Standard Pacific Section;" ninety per cent of the rails to be in length of 24, 26, 28, and 30 feet, ten per cent might be in shorter lengths in even feet, but none under 18 feet, the fish-plates also to be Sandberg's Standard, with such modifications as might be authorized and directed. Date of contract, 23rd December, 1874; date for delivery 1st July, 1876. Quantities and rates as follows:—

Tons.	cwt.	qr.	lbs.					
10,005	10	0	19	Rails	@	$54 62	=	$546,500 83
379	6	2	21	Fish plates	@	54 62	=	20,719 23
83	5	1	5	Bolts & Nuts	@	93 29	=	7,767 72
								$574,987 78
Allowance for Winter Freight								1,423 81
								$576,411 59
Amount paid on account								$576,411 59

All the supplies embraced in this contract have been delivered.

Contract No. 7.

RAILS.—5,000 tons of Bessemer steel rails, with the proportionate quantity of fish-plates, bolts and nuts to be delivered at Montreal. The Ebbw Vale Steel, Iron and Coal Company (Limited), Manufacturers. The specification was the same as that for Contract No. 6. Date of contract February 9th, 1875; date for delivery, during the season of navigation of 1875. The quantities and rates as follows:—

	Tons.	cwts.	qrs.	lbs.				
Rails...........	5,008	18	0	13				
Fish Plates..	188	13	0	21				
	5,197	11	1	6	@ £11, =	£57,173	6	2
Bolts...........	50	0	2	7	@ £24 2s 6d =	1,206	18	10
						£58,380	5	0

Currency..............................$284,117 21

Paid on account.................... 284,117 21

All the supplies embraced in this contract have been delivered.

Contract No. 8.

RAILS.—20,000 tons of Bessemer steel rails, with the proportionate quantity of fish-plates, bolts and nuts, delivered at Montreal. The Mersey Steel and Iron Company (Limited), Manufacturers. The specification was the same as that for Contract No. 6. Date of contract 14th January, 1875; date for delivery, not less than one half during the season of navigation of 1875, and in time to arrive by the first day of October of same year, and the balance on or before the first day of July, 1876, following. The quantities and rates as follows:—

	Tons.	cwts.	qrs.	lbs.				
Rails..........	20,001	15	0	0				
Fish Plates..	790	6	2	17				
Tons,	20,801	1	2	17	@ £11 3s, =	£231,932	6	9

Currency........................... $1,128,737 35

Paid on account $1,128,737 35

All the supplies embraced in this contract have been delivered.

Contract No. 9.

RAILS.—5,000 tons of Bessemer Steel rails, with the proportionate quantity of fish-plates, at at £11 per ton, and bolts and nuts, £20 per ton, delivered at Montreal. The West Cumberland Iron and Steel Company (Limited), Manufacturers. The specification was the same as that for Contract No. 6. Date of Contract, 6th April, 1875; date for delivery, during season of navigation of 1875.

Contract No. 10.

RAILS.—5,000 tons of Bessemer steel rails with the proportionate quantity of fish-plates, at £10 per ton; bolts and nuts at £19 per ton, delivered F.O.B. at Workington, England. The West Cumberland Iron and Steel Company (Limited), Manufacturers. The Specification was the same as that for Contract No. 6. Date of Contract, 6th

April, 1875; date for delivery, during season of navigation of 1875. By subsequent arrangement, this lot was also delivered at Montreal the same rates being paid as per contract No. 9. The quantities and rates as follows:—

	Tons.	cwt.	qrs.	lbs.		
Rails....................	10,000	16	1	10		
Fish-plates............	374	17	1	4		
	10.380	13	2	14	@ £11 =	£114,187 9 6
Bolts and Nuts.......	85	15	0	0	@ £20 =	1,715 0 0
						£115,902 9 6
Currency..						$ 564,058 71
Paid on account..						$ 558,175 52

All the supplies embraced in these contracts have been delivered.

Contract No. 11.

Rails.—5,000 tons of Bessemer steel rails with the proportionate quantity of fish-plates, to be delivered F.O.B. in Liverpool. Naylor, Benson & Co., London, Merchants. The Specification was the same as that for Contract No. 6. Date of contract, 9th February, 1875; date for delivery—2,500 to 3,000 tons in March and April, 1875, but not exceeding 1,000 tons during March, 1875. The remainder in May, 1875. The quantities and rates as follows;—

	Tons	cwt.	qrs.	lbs.		
Rails.................. ..	5,077	3	1	18		
Fish-plates............	109	10	1	4		
	5,186	18	2	22	@ £10 10=	£54,462 16 3
Currency..						$ 265,052 36
Paid on account..						$ 265,052 36

All the supplies embraced in this contract have been delivered.

Contract No. 12.

Georgian Bay Branch.—Extending from the proposed western terminus of the subsidized portion of the Canada Central Railway, to a point on the French River near Georgian Bay. Length about 85 miles. Hon. A. B. Foster, contractor. The contract embraced the cost of surveying and locating the line; the complete construction of the line in running order; the station and terminal accommodation; telegraph line fully equipped; the rolling stock equal in the first place, to $2,500 per mile; and wharf accommodation at the terminus, at River French.

The contractor to be paid at the rate of $10,000 per mile, also interest at the rate of 4 per cent per annum on the sum of $7,500 per mile, for 25 years, and a grant of land equal to 20,000 acres per mile.

Amount paid for surveys......... .... $41,000.

This contract has been cancelled.

Contract No. 13.

Main Line.—Grading and bridging—Fort William to Shebandowan. Length 45 miles. Messrs. Sifton and Ward, contractors. The contract embraces the clearing, grubbing, fencing, excavation, draining, ditching, foundation works, wooden bridges, culverts, and all other works required in connection therewith, according to general specification. Date of contract, 3rd April, 1875; date for completion, 1st August, 1876.

The approximate quantities furnished to contractors, moneyed out at contract rates, are as follows:—

SCHEDULE OF QUANTITIES AND PRICES.

Approximate Quantities.	Description of Work.	Rates.	Amount.
		$ cts.	$ cts.
700 acres	Clearing .... per acre....	20 00	14,000 00
22 "	Close cutting........................ "	40 00	880 00
114 "	Grubbing, including side ditches........ "	60 00	6,840 00
20,000 lineal feet..	Fencing .... per 100 lineal ft..	5 62	1,124 00
30,000 cubic yards	Solid rock excavation .... per cubic yard...	1 25	37,500 00
8,000 " ..	Loose " .... " ...	0 50	4,000 00
944,000 " ..	Earth excavation........................ " ...	0 23	217,120 00
74,000 lineal feet..	Under drains.............. per 100 lineal ft..	50 00	37,000 00
2 spans 100 feet clear	Howe truss bridges................ per span........	3,000 00	6,000 00
6 " 80 "	" " .... "	2,400 00	14,400 00
1 " 60 " ..	" " .... "	1,800 00	1,800 00
4 " 40 " ..	" " .... "	1,000 00	4,000 00
6,800 cubic yards	Crib work in abutments and piers of bridges, including timber and stone filling . ... per cubic yard...	2 25	15,300 00
1,200 " ..	Rip-rap .... " ...	4 00	4,800 00
1,300 lineal feet..	Piles................ per lineal foot ...	0 40	520 00
10,000 " ..	Timber, 16 inches by 12 inches, stringers for trestle bridges and culverts... " ...	0 35	3,500 00
100,000 " ..	Timber, 12 inch square, in trestle bridges, culverts, and cattle guards. " ...	0 30	30,000 00
30,000 " ..	8 inch flatted timber, in trestle bridges, culverts and cattle guards................ " ...	0 15	4,500 00
20,000 feet, B. M...	Hemlock or spruce plank................ per 1,000 ft., B.M.	20 00	400 00
10,000 " ...	Pine plank................ " ...	20 00	200 00
5,000 " ...	Hardwood plank................ " ...	20 00	100 00
20,000 lbs	Wrought iron, including bolts, spikes, straps, &c................ per lb	0 10	2,000 00
3,000 "	Cast iron .... "	0 07	210 00
	Approximate amount of Contract	....	$406,194 00

After the contract was let, a change was made in the location of the line, which cut off about $12\frac{1}{2}$ miles at the westerly end, and reduced the quantity of work about one-third. The contract now terminates at a point near Sunshine Creek, length, $32\frac{1}{2}$ miles.

Approximate amount of contract (as revised)........... $270,796 00
Amount paid on account of work executed.............. 239,220 00

Contract No. 14.

Main Line.—Grading and bridging—Selkirk to Cross Lake. Length, 77 miles. Messrs. Sifton and Ward, Contractors. The contract embraces the clearing, grubbing, fencing, excavation, draining, ditching, foundation works, wooden bridges,

culverts, and all other works required in connection therewith, according to general specifications. Date of contract, 3rd April, 1875. Date for completion, 1st August, 1876.

The approximate quantities furnished to contractors, moneyed out at contract rates, are as follows :—

SCHEDULE OF QUANTITIES AND PRICES.

Approximate Quantities.	Description of Works.	Rates.	Amount.
		$ cts.	$ cts.
1,000 Acres..... ..	Clearing ....per acre.	5 00	5,000 00
100 "	Close Cutting................. .... "	40 00	4,000 00
200 "	Grubbing, including side ditches .... "	60 00	12,000 00
200,000 Lineal feet	Fencing............ ....per 100 lineal feet.	6 00	12,000 00
10,000 Cubic Yds.	Solid rock excavation......... ....per cubic yard.	2 00	20,000 00
3,000 " ..	Loose " .... " "	1 00	3,000 00
1,000,000 " ..	Earth excavation, including borrowing " "	0 26	260,000 00
40,000 " ..	Excavation in off-take ditches beyond Railway limits................... .... " "	0 23	9,200 00
20,000 Lineal Feet	Under drains................................ per 100 lineal feet.	50 00	10,000 00
3 spans, 100 ft. clear.	Howe Truss Bridges..... ... .per span	4,000 00	12,000 00
1 " 80 " ..	" " .... "	3,000 00	3,000 00
1 " 60 " ..	" " .... "	2,500 00	2,500 00
2,500 Cubic Yds.	Crib-work in abutments and piers of bridges, including timber and stone fiilling..... ......per cubic yard	3 00	7,500 00
1,200 " ..	Rip-rap......................... .... " "	4 00	4,800 00
2,400 Lineal Feet	Piles...per lineal foot.	0 50	1,200 00
6,000 " ..	Timber, 16 inches by 12 inches, stringers for trestle bridges and culverts..... .. "	0 60	3,600 00
55,000 " ..	Timber, 12 inches square, in trestle bridges, culverts and cattle guards. "	0 40	22,000 00
1,000 " ..	Timber, 12 inches by 6 inches .... "	0 25	250 00
2,000 " ..	" 9 inches by 6 inches .... "	0 25	500 00
24,000 " ..	8-inch flatted timber........ .... "	0 20	4,800 00
10,000 Feet, B.M...	Hemlock or spruce plank..................per 1,000 feet B.M.	50 00	500 00
8,000 " ..	Pine plank...... .... " "	50 00	400 00
5,000 " ..	Hardwood Plank .... " "	50 00	250 00
20,000 Lbs	Wrought iron, including bolts, spikes, straps, &c.................................... .... per lb.	0 20	4,000 00
3,000 "	Cast iron .... "	0 15	450 00
	Approximate amount of Contract............ "	....	$402,950 00

Amount paid on account of work executed............ $214,500 00

Contract No. 15.

Main Line.—Grading and bridging—Cross Lake to Keewatin. Length, 36½ miles—also track laying and ballasting, Selkirk to Keewatin, length 112 miles. Messrs. Sutton, Thompson & Whitehead, Contractors. The contract embraces the clearing, grubbing, excavation, embankments, tunnelling, drainage, ditching foundation works, wooden bridges, culverts, masonry, the track-laying ballasting, and all other works connected therewith, according to general specifications. Date of contract, 9th January, 1877; date for completion, 1st July, 1 79. The track from Selkirk to Cross Lake to be laid as soon as practicable after the completion of the roadbed by the contractors for the grading of that section.

The approximate quantities furnished to contractors, moneyed out at the contract rates, are as follows;—

SCHEDULE OF QUANTITIES AND PRICES.

Approximate Quantities.	Description of Work.	Rates.	Amount.
		$ cts.	$ cts.
500 acres	Clearing ....per acre ..	30 00	15,000 00
20 "	Close cutting.. " ...	50 00	1,000 00
50 "	Grubbing, including side ditches and off-take drains .... " ...	80 00	4,000 00
300,000 cubic yards	Solid rock excavation .... per c. yard	2 75	825,000 00
30,000 " ...	Loose rock excavation .... " ...	1 75	52,500 00
80,000 " ...	Earth excavation, including borrowing........ " ...	0 37	29,600 00
20,000 " ...	Excavation in off-take ditches, beyond railway limits .... " ...	0 45	9,000 00
10,000 lineal feet ..	Under-drains ....per 100 l. ft.	55 00	5,500 00
1 span, 40 feet clear..	Howe truss........................per span...	600 00	600 00
425 lineal feet ..	Tunnelling for railway (sectional area equal to 15 cubic yards to the lineal foot).. ......per l. foot.	30 00	12,750 00
200 " ...	20-ft. tunnels for streams (12 cubic yards per lineal foot) .... " ...	26 00	5,200 00
160 " ...	16-ft. tunnels for streams (8 cubic yards per lineal foot)........................ " ...	18 00	2,880 00
320 " ...	12-ft. tunnels for streams (4 cubic yards per lineal foot .... " ...	14 00	4,480 00
450 " ...	8-ft. tunnels for streams (2 cubic yards per lineal foot)........................ " ...	9 00	4,050 00
1,300 " ...	6-ft. tunnels for streams (1 cubic yard per lineal foot) .... " ...	7 00	9,100 00
1,000 cubic yards	Rip-rap ....per c. yard	2 00	2,000 00
2,400 " ...	Bridge masonry .... " ...	11 00	26,400 00
380 " ...	Cribwork in abutments and piers of bridges, including timber and stone-filling .... " ...	2 75	1,045 00
	Squared Timber in Trestle-work, Bridges, Culverts, &c.		
500 lineal feet..	16 inches by 12 inches ....per l. foot.	0 33	165 00
84,000 " ...	15 " 12 " .... " ...	0 30	25,200 00
84,000 " ...	15 " 9 " .... " ...	0 30	25,200 00
1,000 " ...	12 " 12 " .... " ...	0 30	300 00
20,000 " ...	12 " 9 " .... " ...	0 28	5,600 00
140,000 " ...	12 " 6 " .... " ...	0 28	39,200 00
245,000 " ...	9 " 9 " .... " ...	0 25	61,250 00
225,000 " ...	9 " 8 " .... " ...	0 25	56,250 00
84,000 " ...	6 " 4 " .... " ...	0 20	16,800 00
	Round Timber in Trestle-work, Bridges, Culverts, &c., of size to square, to following dimensions:		
260,000 " ...	12 inches by 12 inches ....per l. foot.	0 18	46,800 00
44,000 " ...	12 " 10 " .... " ...	0 17	7,480 00
16,000 " ...	12 " 9 " .... " ...	0 17	2,560 00
81,000 " ...	12 " 6 " .... " ...	0 12	9,720 00
14,000 " ...	12 " 4 " .... " ...	0 10	1,400 00
74,000 " ...	9 " 9 " .... " ...	0 12	8,880 00
198,000 " ...	9 " 6 " .... " ...	0 10	19,800 00
15,000 " ...	9 " 4 " .... " ...	0 08	1,200 00
29,000 " ...	6 " 4 " .... " ...	0 06	1,740 00
1,000 " ...	8 inches flatted timber .... " ...	0 12	120 00
645,000 feet, B.M....	Hemlock or spruce plank ....per 1,000, B.M.	12 00	7,740 00
1,000 " ...	Pine plank .... " ...	25 00	25 00
1,000 " ...	Hardwood plank .... " ...	20 00	20 00
325,000 lbs.	Wrought iron, including bolts, spikes, straps, &c. ....per lb.	0 13	42,250 00
10,000 "	Cast iron .... "	0 10	1,000 00
270,000 Number.....	Ties ....per tie	0 40	108,000 00
116 miles	Track-laying ....per mile ..	290 00	33,640 00
186,000 cubic yards	Ballasting ....per c. yard	0 33	61,380 00
26 sets	Points and crossings ....laying each set	10 00	260 00
	Approximate Amount of Contract........................	....	1,594,085 00

Amount paid on account of work executed.......... Nil

Contract No. 16.

Canada Central.—Extension of the Railway from the vicinity of the village of Douglas westward to the eastern end of the main line of the Pacific Railway near Lake Nipissing. The Canada Central Railway Company contractors. The length of line subsidized is about 120 miles, and the subsidy to be granted is at the rate of $12,000 per mile.

Date of Order in Council, 4th November, 1874; date for completion, 1st January, 1877.

Very little progress has been made towards carrying out the work. The sum of $68,000 has been paid on account of rails delivered.

Contract No. 17.

Transportation of Rails from Liverpool, England, to the ports of Esquimalt or Nanaimo, on Vancouver Island, British Columbia; Anderson, Anderson & Co., contractors.

The contract embraces the transportation of about 5,000 tons of steel rails, with their accessories, such as fish-plates, bolts and nuts. Date of contract, 8th April, 1875; date for last shipment, June 1875. The quantities and rates are as follow:—

	Tons.	cwt.	qrs.	lbs.		
Rails..................	5,077	8	1	18		
Fish Plates..........	109	10	1	4		
Bolts and Nuts....	73	4	0	0		
	5,260	2	2	22	@ $9.73 per ton....	$51,181 22
Insurance..						205 03
Freight on Packages..						76 68
						$51,462 96
Amount paid on account...						$51,462 96

Contract No. 18.

Transportation of Rails, fish-plates, bolts, etc., from Duluth to Winnipeg, Man., or any point on the Red River between Pembina and Winnipeg, at the rate of $15 per ton, U.S. currency, and in the event of the channel of the Red River being improved, same rate, viz.: $15 per ton from Duluth to the point of crossing of the Canadian Pacific Railway north of Stone Fort.

Red River Transportation Co., Contractors. Date of contract, May 22nd, 1875; delivery during the season of navigation.

Quantities delivered to date as follows:—

	Tons.	cwt.	qrs.	lbs.	
Rails......	14,492	2	9	14	
Fish plates.........	597	13	0	9	
Bolts..................	51	12	1	3	
	15,141	7	2	1	@ $15 U.S. cy. = $227,123 41

Amount paid on account, $206,171 33, Canadian currency.

Contract No. 19.

Engineer's House, erected at Read's, near Kaministiquia Bridge. Moses Chevrette, Contractor.

The contract embraces all labor, material, plant, and everything necessary for the due completion of the work. Date of contract, 3rd June, 1875; date for completion, 1st August, 1875.

Amount of contract..$1,600 00

Amount paid..$1,600 00

This contract has been completed.

Contract No. 20.

Trasportatiom of Rails: 5,000 tons of rails, with their accessories, from Montreal to Fort William or Duluth. The Merchants's and Lake and River Steamship Company, Contractors. The contract includes the providing of first-class propellers and transport from the Port of Montreal to the Ports of Fort William and Duluth, or either of them, together with all charges for loading and unloading and piling of the same on the wharves or places within a distance of 60 feet from the ship's side; all premiums of insurance; all wharfage or harbour dues at the ports of destination or delivery, with all canal and other tolls chargeable on the route.

Date of contract, 29th July, 1875. Date for completion, season of navigation of 1875.

The quantities and rates are as follows:—

	Tons.	cwt.	qrs.	lbs.		
Rails..........	10,390	19	1	25		
Fish-plates	380	8	3	0		
Bolts and nuts	55	8	0	8		
	10,826	16	1	5	at $6.20 per ton =	$67,126 28

Amount paid on account.. $67,126 28

This contract has been completed.

Contract No. 21.

Transportation of Rails from Montreal to Lachine. Patrick Kenny, Contractor. The contract embraces the taking of the rails from ships' tackles or wharves wherever they may have been landed, transporting the same to the Rock Cut at Lachine, and there discharging and piling the same.

Date of contract, 9th August, 1875. Date for completion, during the season of navigation of 1875.

The quantities and rate are as follows:—

	Tons.	cwt.	qrs	lbs.		
Rails..........	10,977	13	0	4	at 80 cts. per ton =	$8,782 11

Amount paid $8,782 11

This contract has been completed.

Contract No. 22.

Transportation of Rails with their accessories from Montreal to Kingston. Holcomb & Stewart, Contractors. The contract embraces the supply of a number of standard barges with proper steam power and transport, to load, unload and pile the same on wharf to be indicated. Date of contract, 22nd September, 1875; date for completion, during the season of navigation of 1875.

Quantities and rates as follows:—

Tons.	cwt.	qrs.	lbs.		
4,906	8	0	19	@ $1 30 per ton less 10c. per ton for piling done by Government..................	$5,887 70

Amount paid..$5,850 00

This contract has been completed.

Contract No. 23.

Sleepers or Cross Ties to be delivered along line from Fort William westward to the 23rd mile post. Messrs. Sifton & Ward, Contractors. The contract provides for the delivery of 56,000 ties as per specification. Date of contract, 4th October, 1875; date for completion, 1st June, 1876.

Quantity of ties delivered 56,339 at contract rate 26c... $14,648 14

Amount paid.. $14,648 14

This contract has been completed.

Contract No. 24.

Engineer's House to be erected at the Town plot of Fort William. Messrs. Oliver, Davidson & Co., Contractors. The contract embraces all labour, material, plant and everything necessary for the due completion of the work. Date of contract, 6th September, 1875; date for completion, 20th June, 1876.

Amount of contract...........	$3,000 00
Extra allowance for plastering, etc..............................	83 70
	$ 3,083 70
Amount paid	$ 3,083 70

This contract has been completed.

Contract No. 25.

Main Line.—Grading and Bridging—Sunshine Creek to English River; length 80 miles; also track-laying and ballasting from Fort William to near English River; length, 112½ miles. Messrs. Purcell & Ryan, Contractors. The contract embraces the clearing, grubbing, excavation, embanking, draining, ditching, foundation works, wooden bridges, culverts, tracklaying and ballasting, and all other works connected therewith, according to general specification. Date of contract, 7th June, 1876; date for completion to Port Savanne (Lac des Milles Lacs), 1st August, 1877; to English River, 1st August, 1878.

The approximate quantities furnished to contractors, moneyed out at contract rates are as follows:—

SCHEDULE OF QUANTITIES AND PRICES.

Approximate Quantities.	Description of Works.	Rates.	Amount.
		$ cts.	$ cts.
100 acres	Clearing.......................................per acre...	25 00	2,500 00
50 "	Close cutting.. " ...	30 00	1,500 00
200 "	Grubbing (including side ditches and off-take drains .... " ...	80 00	16,000 00
240,000 cubic yards	Solid rock excavation (line cuttings) .... per c. yard	1 50	360,000 00
10,000 " ...	Loose " " .... " ...	0 90	9,000 00
1,000,000 " ...	Earth excavation (including borrowing)...... " ...	0 33	330,000 00
10,000 " ...	Excavation in off-take ditches beyond railway limits .... " ...	0 35	3,500 00
60,000 lineal feet..	Under drains ....per 100 lineal feet..	10 00	6,000 00
4 spans, ...	Howe truss bridge 100 ft. clear....... ....per span...	4,000 00	16,000 00
2 "	" 80 " .... " ...	2,800 00	5,600 00
6 "	" 60 " .... " ...	2,100 00	12,600 00
6 "	" 40 " .... " ...	1,200 00	7,200 00
9,000 cubic yards	Crib work in abutments and piers of bridges (including timber and stone filling) ......per c. yard	4 00	36,000 00
2,000 " ...	Rip-rap.. " ...	2 50	5,000 00
5,300 lineal feet ..	Piles driven ....per l. foot.	0 25	1,325 00
14,000 " ...	Timber, 16 inches by 12 inches, stringers in trestle bridges and culverts .... " ...	0 50	7,000 00
96,000 " ...	Timber, 12 inches square, in trestle bridges, culverts and cattle guards .... " ...	0 40	38,400 00
4,000 " ...	Timber, 12 inches by 6 inches, in work......... " ...	0 20	800 00
45,000 " ...	" 9 " 8 " " .... " ...	0 20	9,000 00
28,000 " ...	" 9 " 6 " " .... " ...	0 18	5,040 00
11,000 feet B.M ...	Hemlock or spruce plank, in work ....per 1,000 B.M.	16 00	176 00
32,000 " ...	Pine plank, in work .... " ...	20 00	640 00
4,000 " ...	Hardwood, plank, in work........................ " ...	20 00	80 00
49,000 lbs	Wrought iron, including bolts, spikes, straps, &c., in work .... per lb	0 10	4,900 00
10,000 "	Cast iron .... "	0 10	1,000 00
210,000 ties.........	....per tie......	0 26	54,600 00
112 miles	Track laying.. per mile ...	300 00	33,600 00
180,000 cubic yards	Ballasting..per c. yard	0 38	68,400 00
24 sets...................	Points & crossings..laying each	50 00	1,200 00
	Approximate amount of Contract..................	....	1,037,061 00

Amount paid on account of work executed.......... $129,100 00

The work is being energetically prosecuted, the rails are laid twenty-five miles, and it is expected that Fort William will be connected with Port Savanne by September next.

Contract No. 26.

ENGINE HOUSE at the town plot of Fort William. James Isbester, contractor. The contract embraces all kinds of labour, machinery, materials and everything necessary for the due execution and completion of a ten-stall engine house. Date of contract, 17th July, 1876; date for completion, 1st August, 1877.

Amount of contract.. $30,989 00

Amount paid on account of work executed............. 14,800 00

Contract No. 27.

TRANSPORTATION OF RAILS from Montreal, Lachine and Kingston to Fort William or Duluth. The Merchants and Lake and River Steamship Company, Contractors. The contract includes the providing of first-class propellors and transport from the ports above named to Fort William and Duluth or either of them, together with all charges for loading, unloading and piling of the same on the wharves or places within a distance of sixty feet from the ship's side, all premiums of insurance, all wharfage or harbour dues at the ports of destination or delivery, with all canal or other tolls chargeable on the route. Date of contract, 16th May, 1876; date for completion, season of navigation, 1876.

The quantities and rates are as follows:—

	Tons.	cwt.	qr.	lbs.		
Rails,	19,652	11	2	22	Montreal to Fort William or Duluth, at $4.50 Lachine " " at 4.50	$88,436 62
Rails,	130	0	0	0	—Kingston " " at 2.75...	357 50
Rails,	100	0	0	0	—Kingston " " at 3.25...	325 00
						$89,119 12

Amount paid,.. $89,060 00

The contract has been completed.

Contract No. 28.

TRANSPORTATION OF ROLLING STOCK, fish plates, bolts, spikes, switch-gear, &c., from St. Paul or Duluth, to Manitoba. The Red River Transportation Company, Contractors. Date of contract 16th May, 1876; date for completion, season of navigation.

The quantities and rates are as follows:—

	U.S. Cy.
Fish-plates, bolts, spikes, crossings and switch-gear, at..	$0 75 per 100 lbs.
Locomotive and tender to Moorhead, at............	0 35 per mile.
" " Moorhead to Manitoba, at	1 00 per 100 lbs.
Passenger or baggage cars to Moorhead at........	0 15 per mile.
Do do Moorhead to Manitoba, at	0 75 per 100 lbs.
Box car to Moorhead....................................	0 10 per mile.
Flat car "	0 08 per mile.
Box or flat cars, Moorhead to Manitoba.	0 75 per 100 lbs.

No work performed under this contract to date.

Contract No. 29.

RAILWAY SPIKES, to be delivered on the wharf at Fort William or Duluth. Messrs. Cooper, Fairman & Co., Contractors. Date of contract, July 28. 1876. 25 tons to be delivered on or before the 15th August, 1876; the remainder at suitable periods thereafter.

Contract for 150 tons, at $57.00 per ton.............. $8,550 00

Amount paid.. 4,275 00

Contract No. 30.

Bolts and Nuts delivered in Montreal or Toronto. Messrs. Cooper, Fairman & Co., Contractors. The contract embraced the delivery of bolts and nuts, as above, manufactured according to sample furnished by Mr. C. P. Sandberg. Date of contract, 5th March, 1875.

Contract for 160 tons, at $101	$16,160 00
Amount paid	16,160 00

This contract has been completed.

Contract No. 31.

Bolts and Nuts delivered in Vancouver Island, British Columbia. Messrs. Cooper, Fairman & Co., Contractors. The contract embraced the delivery of bolts and nuts, as above, manufactured according to sample furnished by Mr. C. P. Sandberg. Date of contract, 5th March, 1875; to be delivered during the year 1875.

Tons	cwt.		
43	4	at $94 90	$4,099 68
30	0	at 90 04	2,701 01
		Amount of contract	$6,800 69
		Amount paid	$6,800 69

This contract has been completed.

GENERAL SPECIFICATION

For the Construction of the Work now being carried into execution under certain of the foregoing Contracts.

1. This specification refers to all works of construction and materials required in making and building the railway up to *formation level*, and preparing it for the permanent way: comprising clearing, close cutting, grubbing, fencing, excavation, tunnelling, draining, ditching, foundation works, bridges, culverts. Also track-laying, ballasting, and all other works connected with the construction and completion of the line of railway, to which the Engineer may consider this specification to be applicable under each contract.

CLEARING, CLOSE CUTTING AND GRUBBING.

2. The clearing is embraced in the contract for the erection of the telegraph; but in the event of the Telegraph Contractor failing to execute this portion of the work, the Contractor for grading may be required and directed to do it; a price for clearing is therefore necessary.

3. Where the railway passes through wooded sections, the land must be cleared to the width of sixty-six feet on each side of the centre line, or such greater or lesser width as the Engineer may direct.

4. The clearing is to be done so that all the brush, logs and other loose material within its limits shall be burned. In no case shall any of the brush or logs be cast

back upon the adjacent timber lands; they must invariably be made into piles near the centre of the space to be cleared, and there entirely consumed. All brush or trees accidentally or otherwise thrown into the adjacent woods, must be dragged out and burned. The land when cleared must be left in a clean condition, and the Contractor will be held responsible for all damage to crops and timber.

5. Where embankments are to be formed less than four feet and more than two feet in height, all the standing timber and stumps must be chopped close to the ground within the limits of the embankment, and burned.

6. Where excavations do not exceed three feet in depth, or embankments two feet in height, all stumps must be grubbed out and if possible burnt; those that will not burn must be carried beyond the limits of the cuttings and embankments, where directed, and there piled. Directions will be given at the proper time as to the extent of ground required to be cleared, close-cut and grubbed. The side ditching and off-take drains must also be grubbed, but no grubbing will be paid for in borrowing pits.

FENCING AND GATES.

7. The fence, wherever required, shall be a strong, well-built, heavy farm fence of approved design, thoroughly secured by stakes, riders, posts and yokes, or other means to prevent its removal by gales of wind or animals.

8. The farm gates, when required, will be light and strong, of an approved design, similar to those on the Intercolonial Railway.

9. The fencing to be thoroughly completed through all the cleared lands, and wherever it may be directed to be placed by the Engineer.

GRADING, EMBANKMENTS, DITCHING, ETC.

10. In woodland the grading will be commenced after the clearing, close cutting and grubbing required is completed to the satisfaction of the Engineer.

11. The width of embankments at sub-grade or formation level will be 17 feet. The width of cuttings will not be less than 22 feet. The slopes of earth work will generally be made one and a half horizontal to one perpendicular. In rock cuttings the slopes will be, as a rule, one horizontal to four perpendicular. In cuttings partly earth and partly rock, a berm of 6 feet shall be left on the surface of the rock. The widths, slopes and other dimensions above defined may be varied by the Engineer at any time, to suit circumstances. And the Contractor shall not take out nor be paid for rock, nor any other excavation beyond the slopes, without an express order, in writing, from the Engineer. In the event of a slide in a rock cutting after it is formed, the Contractor will remove the *debris*, and be paid for it as loose rock or as earth, according to the class to which it may appear to the Engineer to belong.

12. The material to be placed in the embankments must be approved by the Engineer, and in places where the natural surface of the ground upon which the embankment is to rest is covered with vegetable matter which cannot be burned off in clearing, and which would, in the opinion of the Engineer, impair the work, the same must be removed to his entire satisfaction. All sloping ground covered with pasture shall be deeply ploughed over the base of the embankments before the latter are commenced.

13. In level prairie sections it will be necessary to excavate off-take ditches for considerable distances to the right or left of the line. These ditches will generally be required in the lowest ground, where the material is frequently of a tough nature (locally known by the name of "Gumbo"). These off-take ditches must be of such widths and depths as may be required and directed. The sides shall be sloped one vertical to two horizontal, and the material shall be cast out so as to leave a berm of at least six feet between the deposit and the top of the slopes. A separate price for off-take ditches will be required in the tenders, and the quantities shall embrace all excavation in connection therewith, beyond the limits of the railway land.

14. Side-hill ground to be covered by embankment shall first be thoroughly underdrained as the Engineer may see expedient, and all cuttings after being formed, and all slopes likely to be affected by wet, must be similarly underdrained, longitudinally or transversely, or both, as circumstances may seem to him to require. These drains will be constructed in a similar way to that in which ordinary land drains are sometimes made; a trench will first be dug to a minimum depth of four feet, and in the bottom of this trench, three or four cedar or spruce poles from two to three inches in diameter will first be laid by hand, breaking joint; over the poles will then be placed not less than three feet of small broken stone, not larger than ordinary road metal or good gravel ballast, over which will be deposited such material convenient to the place as the Engineer may approve of. The Contractor must find all the material required in these drains, do all the work described and remove the surplus earth. These drains must always be made with a sufficient longitudinal fall for the easy flow of the water, and therefore they may in level cuttings be deeper at one end than at the other, but the minimum depth will be not less than four feet.

15. On the completion of the line cuttings and the underdrains provided for in last clause, ditches for the removal of surface water shall be formed along each side at the bottom of the slopes, in cuttings, according to directions to be given. Catch water ditches shall also be formed some distance back from the top of slopes, to exclude from the excavation any water flowing from the adjoining lands; the Contractor shall also construct all other drains and ditches which the Engineer may deem necessary for the perfect drainage of the railway and works.

16. All open ditches in cuttings or elsewhere, other than those referred to in clause 13, and all excavations required for turning, making, or changing watercourses, and which must be executed as may from time to time be directed, will be measured up and paid for as excavation according to its class, and all other excavations such as may be required in the formation of public roads, or in borrowing pits, or in grading depot grounds, turnouts or branches, and so much of foundation pits for bridges and culverts as are not under the level of the water, shall be considered as a necessary part of the excavation for the formation of the roadway, and must be executed and the material deposited according to the directions of the Engineer, and will be paid for at the same rate per yard as the ordinary excavation, according to its class. In foundation pits, where pumping or bailing becomes necessary, all the excavation under water level shall be measured and reckoned *at three times the price of earth excavation*, in order to cover the extra cost involved.

CLASSIFICATION OF EXCAVATION WORKS, ETC.

17. Excavation will be classed under three heads, *viz.: Solid Rock*, *Loose Rock*, and *Earth*, and will be paid for according to the following definitions:

1st. All stones and boulders measuring more than 40 cubic feet, and all solid quarry rock, shall be termed *Solid Rock Excavation*.

2nd. All stones and boulders measuring more than 14 cubic feet, and less than 40 cubic feet, and all loose rock, whether in situe or otherwise, that may be removed with facility by hand, pick or bar, without the necessity of blasting, shall be termed *Loose Rock Excavation*.

3rd. All other excavation of whatever kind, with the exception of off-take ditches referred to in Clause 13, shall be termed *Earth Excavation*.

18. The contract price for these several classes of excavation shall be taken to include the whole cost of hauling, except only extreme cases which may involve a haul of more than twelve hundred feet. For every hundred feet of haul over twelve hundred feet and up to twenty-five hundred feet, the Contractor will be allowed at the rate of one cent per cubic yard, that is to say in the event of the haul being in any case twenty-five hundred feet, thirteen cents per yard shall be added to the schedule rate; which will be the maximum allowance for haul in any case. This clause shall not apply to ballast.

19. The embankments must be made to such sufficient height and width as will allow for the subsidence of the same, so that on being trimmed they will stand at the full dimensions specified in Clause 11, or at such heights, levels, widths and forms as may be directed by the Engineer, the upper surface of the banks to be rounded in order to throw off the water.

20. The whole of the grading shall be carefully formed to the levels given, and the roadway in cutting shall invariably be rounded and left from six to eight inches lower at the sides than on the centre line. In rock cuttings it will be sufficient to form a water channel about two feet wide and eight inches deep along each side. All materials found in excavations, whether in road-bed cuttings, ditches, water channels, road crossings, borrowing pits or elsewhere, must be deposited in such places as the Engineer may direct. In cases where the road-bed excavations are insufficient to form the embankments, the deficiency shall be supplied by widening the cuttings, or from the side ditches, or from borrowing pits, but no material shall be so supplied without his concurrence, and not until the cuttings are completed, without his express sanction. All borrowing pits shall, if required by the Engineer, be dressed to a good shape and properly drained. Where material to make up embankments is taken from the sides of the embankment, a berm of at least ten feet from bottom of slope of embankment shall remain untouched.

21. Where the excavation in a cutting exceeds what may be required to make the embankments of the specified width, the Engineer may direct that the embankments be increased in width with the surplus material, and when this is done to his satisfaction, the remainder, if any, may be wasted; but in every case where either borrowing or wasting is resorted to, the materials must be taken and deposited as he may regulate and direct.

22. In cases where pitching or rip-rapping will be required for the protection of embankments contiguous to streams, all stone suitable for this work found in excavations may be removed and deposited in some convenient place until required, and all good building stone which may be found in rock excavations may, with the approval of the Engineer, be preserved and piled along the side of the line as directed. But any material so found and used will not be paid for twice, the quantity, if considerable, will form a deduction from the quantity of excavation as measured in the cutting.

23. Rip-rap work, wherever required and ordered for the protection of slopes of embankments, must be well and carefully performed, in such manner and of such thickness as may be directed. It will be measured and paid for by the cubic yard.

24. Roads constructed to and from any point on the line of Railway for the convenience of the Contractor, for the conveyance of material or otherwise, must be at his own risk, cost and charges, and he must pay for the use of the land for the same.

25. Wherever the line is intersected by public or private roads, the Contractor must keep open at his own cost convenient passing places, and he shall be held responsible for keeping all crossings during the progress of the works, in such condition as will enable the public to use them with perfect safety, and such as will give rise to no just ground for complaint. Contractors will be held liable for any damages resulting from negligence on their part or that of their men. At all public roads crossed on the level, the Contractor will be required to put in two substantial cattle guards of wood of such dimensions as may be directed by the Engineer.

26. Whenever any material is met with in the excavations, which the Engineer shall consider suitable and required for ballast, the same shall at his discretion be reserved for that purpose.

27. When slips occur in cuttings, after they are properly formed, the material must be immediately removed by the Contractor, the slopes re-formed, and such precautions adopted as the Engineer may deem necessary. The Contractor will be paid for the removal of slips as already provided for.

28. In the event of earth excavation being proceeded with in winter, no snow or ice must be placed in embankments, or allowed to be covered up in them, and all frozen earth must as far as practicable be excluded from the heart of embankments.

29. The Contractor shall, before the work is finally accepted, finish up cuttings and embankments, dress and drain borrowing pits when required, dress slopes to the required angles, repair all damages by frost or other causes, and complete everything connected with the grading of the road-bed, &c., in a creditable and workmanlike manner, in accordance with the directions and to the satisfaction of the Engineer.

30. The measurement of quantities shall invariably be made in excavation, unless in special cases, if any, where this may be found impossible; in such cases the Engineer shall determine the quantities in embankment, after making all proper allowances, of which he shall be the judge.

31. The prices stipulated for excavation of the several denominations, together with the price for haul in extreme cases, and the price for work in foundation pits under water level, shall be the total prices for excavating, loading, removing and depositing all the material. In a word, the rates and prices stipulated in the contract must be understood to cover every contingency; the furnishing of all labour, material, power and plant; the cost of finishing up cuttings and embankments, the dressing and draining of borrowing pits, when required; the dressing of slopes to the required angle, and the completing of everything connected with the grading of road-bed, in a creditable and workmanlike manner, in accordance with the directions and to the satisfaction of the Engineer.

TUNNELLING.

32. The tunneling will consist of "Line Tunnels" and "Stream Tunnels"; the former shall be formed to an exact minumum section hereafter to be furnished. For the purpose of tendering, the sectional area of "Line Tunnels" shall be calculated at 405 superficial feet, equal to 15 cubic yards to the lineal foot of tunnel. The "Stream Tunnels," where formed, shall be driven through the solid rock which, in some places, form the sides of ravines; they must be formed in the manner to be pointed out in each case. Open cuttings at the end will be excavated te give an easy flow to the water; these open cuttings may be slightly curved, but the tunnels proper must be perfectly straight from end to end, with the sides as smooth as practicable. The up-stream end in each tunnel must generally be one foot lower than the bed of the stream at that point, and the tunnel must be driven with a proper inclination. Care must be taken to leave a solid pillar of rcok between the tunnel and the side of the ravine, equal (except in special cases) to not less than about double the diameter of the tunnel. The thickness of solid rock over the tunnel shall be similarly proportioned. The open cuttings which forms the outlets and inlets of tunnels, shall be measured and paid as ordinary excavation according to classification; the material excavated from them to be placed in the embankments; or as may be directed. The tunnels shall be paid for by the lineal foot, and the price must cover all cost of pumping, bailing, draining, &c., which may be necessary. The tunnels required will be of the following general dimensions:—

		Sectional areas.				Per lineal foot of tunnel.	
Twenty feet	tunnels,	324	superficial	feet	equals	12	cubic yards.
Sixteen feet	"	216	"	"	"	8	" "
Twelve feet	"	108	"	"	"	4	" "
Eight feet	"	54	"	"	"	2	" "
Six feet	"	27	"	"	"	1	" "

TIMBER STRUCTURES.

33. The structures for the passage of small streams may be built of the most suitable wood to be found in the country. Character and quality to be approved by the Engineer. The several structures are intended to be built according to the following specification and the drawings referred to; but the character of the designs may be changed to suit circumstances.

34. General Drawings No. 1 to 9, inclusive, show the kind of structures to be erected for the passage of the smaller streams under the railway.

Drawing	No. 1,	for embankments		2 feet	high.
"	No. 2,	"	"	4	"
"	No. 3,	"	"	6	"
"	No. 4,	"	"	8	"
"	No. 5,	"	"	10	"
"	No. 6,	"	"	15	"
"	No. 7,	"	"	20	"
"	No. 8,	"	"	25	"
"	No. 9,	"	"	30	"

35. No. 1 will be composed of two bents framed together in the manner shewn in the drawing, having cap and mud-sills framed into post and braces, and pinned as shewn. These bents will be placed in trenches—previously excavated—11 feet centre to centre, and at least 5 feet in the ground, and when properly levelled as to grade, height, &c., the earth will then be firmly packed around them. These bents will be spanned by stringers 16 inches by 12 inches, and bolted by $\frac{7}{8}$ inch bolts—with washers—to the caps. The bank stringers will be 12 inches by 12 inches. The whole then covered by ties 9 inches by 8 inches, and of the lengths shewn in the plan.

36. No. 2 will be similar in every respect to No. 1, except as to height of bents. See drawing.

37. No. 3 will be composed of four bents; each bent will have cap and mud-sills 12 inches by 12 inches, and four posts 12 inches by 12 inches, and two braces 12 inches by 12 inches, all framed together and pinned in the manner shewn. There will be two diagonal braces of 9 inches by 6 inches placed in each bent in the manner shewn, and bolted to the frames by $\frac{7}{8}$ inch bolts with washers under the heads of nuts and bolts, seven bolts to each brace. Trenches will be dug for the reception of these bents 11 feet centre to centre, and 5 feet deep, and when the bents have been levelled up to grade height and placed in line, the earth will then be tramped firmly round them. Stringers of 16 inches by 12 inches must be provided and bolted to cap by $\frac{7}{8}$ inch iron bolts with washers. The bank stringers will be 12 inches by 12 inches; the whole structure will then be covered with special ties 9 inches by 8 inches as shewn.

38. Nos. 4 to 9 will be similar to No. 3 already described. No. 6 will have six bents, No. 7 eight bents, No. 8 eight bents and No. 9 ten bents, and they will increase in height according to the height of the bank. In cases where stringers cannot be procured long enough to span the entire number of bents as in the cases of Nos. 6, 7, 8 and 9, then the stringers may be joined either by butt joint on corbells resting on cap-sills, or be allowed to overlap each other on cap all being firmly bolted to caps.

39. Wherever the circumstances of the case require the adoption of trestle work in lieu of embankments, the same shall be erected in the most substantial manner in accordance with the plans and specifications of same to be furnished from time to time by the Engineer.

40. Wherever the circumstances of the case require the adoption of bridges on piles, they will be erected according to the following or another approved plan. Trenches will first be excavated 21 feet centre to centreand to the depth of the beds of the streams. Each bent will be composed of four piles driven perpendicularly,together with two spur piles as shewn in the drawing. The piles are to measure at the butt or larger end not less then 12 nor more than 17 inches in diameter, exclusive of bark. They must be perfectly sound and straight, and be of such lengths as circumstances may require. The piles must be driven by a hammer weighing 1,500 lbs. or upwards, until they reach perfectly firm ground. They will generally be tested by the hammer falling 30 feet at the last blow. Care must be taken to have them driven truly, so that the caps, waling pieces and braces may be properly framed and bolted to them. The spur piles must be curve-pointed, so that as they are driven they will gradually come into their places and butt against the piles and be bolted to the same, with two

bolts to each spur pile. Before being driven the piles must be sawed or chopped off square at the butt, and tapered to a blunt point at the smaller end. Should there appear to be any danger of splitting, the heads must be bound with iron hoops, and if necessary the points must also be properly shod. The stringers must be double, 12 inches by 16 inches bolted together and resting on corbells, and be bolted securely to corbells and caps. The stringers must be of as long lengths as possible, and to break joint alternately inside and out. The bank stringers will be 16 inches by 12 inches. The whole to be covered by special ties 9 inches by 8 inches as shewn.

41. The railway will be carried over the larger streams by bridges. The abutments and piers will in some cases be built of crib work filled with stone. The cribs must be constructed in the most substantial manner of the most suitable timber to be found in the vicinity, outside timbers to be not less than 12 inches square, dove-tailed at angles, and properly pinned with hardwood pins or rag-bolts of iron as the Engineer may direct; the ties may be of suitable round timber dove-tailed into face timbers and pinned. The sloping faces of the cut-waters to piers must be square timber laid with one side in the line of the rake of the cut-water and be dove-tailed at angles, the two faces of the cut-waters will then be sheathed with hardwood plank 3 inches thick, well fastened to the crib work with spikes or rag bolts. The whole of the abutments and piers to be finished in accordance with the plans and to the satisfaction of the Engineer.

42. Where the circumstances of the case require the adoption of timber bridges. their superstructure will be of the most improved Howe Truss pattern, built of pine, with white oak keys, cast iron prisms, and wrought iron rods with up-set ends, the whole to be first class material and workmanship, but the Engineer may vary the design and the kind of timber if found necessary. Detail drawings will be prepared, during the progress of the work by the Engineer to suit each span and bridge, and to which the contractor must work. These bridges must be executed in a thoroughly substantial and workmanlike manner, and shall be completed in every respect except painting which will not be included in the present contract.

IRON BRIDGES.

43. The Government reserves the right to substitute and furnish iron superstructures for bridges in lieu of timber, and to take such steps as may be deemed best for placing the same in position. In the event of this right being exercised after the contractor has incurred expense in procuring some of the timber, he shall not be entitled to any compensation on account of the substitution beyond the value of the material furnished and the labour expended thereon.

FOUNDATIONS.

44. Foundation pits must be sunk to such depths as the Engineer may deem proper for the safety and permanency of the structure to be erected; they must in all cases be sunk to such depth as will prevent the structures being acted on by the frost. The material excavated therefrom to be deposited in embankment, unless the Engineer direct otherwise.

BRIDGE AND CULVERT MASONRY, MORTAR, ETC.

45. In order to prevent delay it will be expedient generally to build the structures in the first place of timber, but should it be practicable to insert structures of masonry at one or more places, without interfering with the progress of the work, and it appear expedient to do so, the Engineer may be authorized to substitute masonry for wooden structures. In such cases the work must be of a substantial and permanent character, and in every respect equal to the best description of masonry in Railway works.

46. The masonry shall not be started at any point before the foundation has been properly prepared, nor until it has been examined and approved by the Engineer, nor until the Contractor has provided a sufficient quantity of proper materials and plant to enable the work to be proceeded with regularly and systematically.

47. The stone used in all masonry on the line of railway, must be of a durable character, large, well proportioned and well adapted for the construction of substantial and permanent structures; parties tendering must satisfy themselves as to where fitting material for the masonry can be most conveniently procured.

48. *Bridge Masonry* shall generally be in regular courses, of large well-shaped stone, laid on their natural beds, the beds and vertical joints will be hammer dressed, so as to form quarter-inch joints. The vertical joints will be dressed back square 9 inches, the beds will be dressed perfectly parallel throughout. The work will be left with the "quarry face" except the outside arrises, strings, and coping, which will be chisel dressed.

49. The courses will not be less than twelve inches, and they will be arranged in preparing the plans to suit the nature of the quarries, courses may range up to 24 inches and the thinnest courses invariably be placed towards the top of the work.

50. Headers will be built in every course not farther apart than 6 feet, they will have a length in line of wall of not less than 24 inches, and they must run back at least three times their height, unless when the wall will not allow this proportion, in which case they will pass through from front to back. Stretchers will have a minimum length in line of wall of 30 inches, and their breadth of bed will be at least $1\frac{1}{2}$ times their height. The vertical joints in each course must be arranged so as to overlap those in the course below 10 inches at least. The above dimensions are for minimum courses of 12 inches, the proportions will be the same for thicker courses.

51. The quoins of abutments, piers, &c., shall be of the best and largest stones, and have chisel drafts properly tooled on the upright arris, from two to six inches wide, according to the size and character of the structure.

52. Coping stones, string courses and cut-waters shall be neatly dressed in accordance with plans and directions to be furnished during the progress of the work.

53. The bed stones for girders shall be the best description of sound stone, free from drys or flaws of any kind, they must not be less than 12 inches in depth for the small bridges, and eight feet superficial area on the bed. The larger bridges will require bed stones of proportionately greater weight; these stones shall be solidly and carefully placed in position, so that the bridge will sit fair on the middle of the stone.

54. The backing will consist of a flat bedded stone, well shaped, having an area of bed generally equal to four superficial feet or more. Except in high piers or abutments, two thicknesses of backing stone, but not more, will be allowed in each course, and their joints must not exceed that of the face work. In special cases, where deemed necessary by the Engineer, to insure stability, the backing shall be in one thickness; the beds must, if necessary, be scabbled off, so as to give a solid bearing. No pinning will be admitted. Between the backing and face stones there must be a good square joint, not exceeding one inch in width, and the face stones must be scabbled off to allow this. In walls over three feet in thickness, headers will be built in front and back alternately, and great care must be taken in the arrangement of the joints so as to give perfect bond.

55. *Culvert Masonry* shall be built of good, sound, large, flat-headed stones, laid in horizontal beds. It may be known as random work, or broken coursed rubble. The stones employed in this class of masonry will generally be not less in area of bed than three superficial feet, nor less in thickness than eight inches, and they must be hammer dressed, so as to give good beds with half-inch joints. In smaller structures, and in cases where stones of good size and thickness cannot be had, they may, if in other respects suitable, be admitted as thin as five inches. All stones must be laid on their natural beds.

56. Headers shall be built in the wall, from front and back alternately, at least one in every five feet in line of wall, and frequently in the rise of wall. In the smallest structure headers shall not be less than twenty-four inches in length and the minimum breadth of bed allowed for stretchers shall be twelve inches. In the larger structures all stones must be heavier in proper proportion. Every attention must be paid to produce a perfect bond, and to give the whole a strong, neat, workmanlike finish.

57. Wing walls will generally be finished with steps, formed of sound, durable stone, and not less than from 10 to 12 inches thick, and 6 feet superficial area; other walls will be covered with coping of a similar thickness, and of seven feet or upwards, superficial area. Those coverings will be neatly dressed when required, and as may be directed. The walls of the box culverts will be finished with stones the full thickness of wall, and the covers will be from 10 to 15 inches thick, according to the span; they must have a bearing of at least 12 inches on each wall, and they must be fitted sufficiently close together to prevent the earth from falling through.

58. *Arches of* 10 *feet span and upwards* will be constructed of stones cut so that, when laid, their beds will radiate truly from the centre of the circle, the depth of stones will of course vary with the span, but will never exceed 30 inches; they must not be less in length than 27 inches and they must break joint ten inches; their thickness on the soffit must be at least 9 inches, and it will be dressed to the circle. All the stones must be dressed to the full depth of bed so as to give truly radiated joints from 3-16 to ¼-inch, they must be set without pinning of any kind and the end joints must be properly squared. Each stone to be full bedded in cement, and each course afterwards thoroughly grouted. The outer ring stones to be neatly worked with a chisel draft around their edges.

59. *Arches of* 8 *feet span and under* shall be constructed of suitable flat bedded stones ranging according to the span from 16 to 24 inches deep and with a minimum length of from 16 to 24 inches, and 5 to 6 inches in thickness on the soffit, they must invariably extend through the entire thickness of the arch. Each stone to be well and closely fitted so as to give half-inch joints and to break joints with its fellow 7 to 9 inches. The whole must be laid in thin cement mortar and each course must be well grouted immediately after being laid. The outer arch stones to be as nearly uniform in depth as possible, of large size and neatly incorporated with the perpendicular face of the masonry. The key stones to be 10 or 12 inches on the soffit, to have a chisel draft around their edges, and to project beyond the face of the wall 2 or 3 inches.

60. All arches shall be built in cement, and before being covered with earth or the centering removed, they must be thoroughly flushed on the back, levelled up and rounded to a moderately even and smooth surface with the same material.

61. Centres of arches must in all cases be well formed, of ample strength, securely placed in position, and in every respect to the satisfaction of the Engineer. The ribs must not be placed farther apart than three feet in any case. The laggings shall be cut to a scantling of three inches square. The supports of centres shall be substantial and well constructed. and they must be provided with proper wedges for easing centres when required.

62. Structures having more than one arch shall be provided with as many centres as the Engineer may deem proper, and in no case shall the centres be struck without his sanction.

63. Centering and scaffolding of all kinds shall be provided by the contractor, and the cost included in the price for masonry.

64. The bottoms of culverts will be paved with stones set on edge, to a moderately even face, packed solid, the interstices being also well packed. The paving will be from 12 to 16 inches deep.

65. Masonry shall be formed *dry* or *laid in mortar* as circumstances may determine. In *dry* masonry special regard must be paid to the stone being massive and well proportioned.

66. Mortar shall be of hydraulic lime or cement, and common lime.

67. Hydraulic lime mortar will be used, unless otherwise directed, in building all masonry, from the foundations up to a line two feet above the ordinary level of the stream. It will be used also in turning arches, in laying girder beds, coping, covering of walls generally, in lipping and in pointing. The hydraulic lime or cement must be fresh ground of the best brand, and it must be delivered on the ground, and kept till used, in good order. Before being used, satisfactory proof must be afforded the Engineer of its hydraulic properties, as no inferior cement will be allowed.

68. Common lime mortar must be made of the best common lime and will be employed in all masonry (except dry) where cement is not directed to be used.

69. Both cement and lime must be thoroughly incorporated with approved proportions of clean large grained sharp sand. The general proportions may be one part of lime to two parts of sand, but this may be varied according to the quality of the lime or cement. Mortar will only be made as required, and it must be prepared and used under the immediate direction and to the satisfaction of an Inspector, by the contractor's men, failing which, the Inspector may employ other men to prepare the mortar, and any expense incurred thereby shall be borne by the Contractor. Grout shall be formed by adding a sufficient quantity of water to well tempered and well proportioned mortar.

70. When mortar is used, every stone must be set in a full bed and beaten solid; the vertical joints must be flushed up solid, and every course must be perfectly level and thoroughly grouted.

71. In all walls built in common lime, the exposed faces will have a 4-inch lipping of cement.

72. All masonry must be neatly and skilfully pointed, but if done out of season, or if from any other cause it may require repointing before the expiration of the contract, the contractor must make good and complete the same at his own cost. Work left unfinished in the autumn must be properly protected during the winter by the Contractor, at his risk and cost.

73. A puddle-wall, at least 2 feet thick, extending from end to end of the masonry, and from the bottom to the top, must be made between the back of the dry masonry and the embankment.

74. After the masonry of a structure has been completed for a period of four or five weeks, the formation of the embankment around it may be proceeded with. The earth must be carefully punned in thin layers around the walls, and in this manner the filling must be carried up simultaneously on both sides. The Contractor must be extremely careful in forming the embankments around culverts and bridges, as he will be held liable for any damages to the structures that may arise. The punning must be carefully attended to, and the whole filling must invariably be done in uniform courses from the bottom to the top of the embankment, without loading one side of the masonry more than another.

TRACK LAYING AND BALLASTING.

75. The work of track laying and ballasting will embrace all engines, cars and plant (unless otherwise provided in the contract), and all labour and tools required for loading, unloading, and distributing rails, joint-fastenings, spike, points and crossings, and sleepers or cross-ties; laying, lifting, centreing, lining and surfacing the track; also, for making roads to ballast pits and laying all service tracks; for getting, loading and unloading the ballast, placing the same in the road bed and trimming it up. At the close of the contract any engines or cars which may be considered by the engineer fit for further use, may be transferred to the Government on the valuation of the Engineer.

76. The Government will furnish to the Contractor rails, joint-fastenings, spike, points, crossings and switch-gear.

77. The rails, joint-fastenings, spike, and points and crossings, will be delivered by the Government to the Contractor at places to be indicated, from whence they shall be distributed by the Contractor.

The rails shall be laid to a gauge of 4-ft. 8½ inches clear between the rails, and they shall be well and carefully fastened at the joints, which must be as near as possible opposite each other and on the same tie, special care must be taken at points and crossings to have the rails laid to a tight gauge, the rails must be full spiked, and on curves the outer rail shall be elevated (unless otherwise directed), according to the degree of curvature as follows, that is to say, on one degree curves 0.05 feet, on two degree curves 0.10 feet, on three degree curves 0.15 feet, and on four degree curves 0.20 feet. The rails shall be handled with great care, and before being run over by either engine or cars, they shall be full sleepered and surfaced. Every precaution shall be taken to prevent them getting bent during the progress of the ballasting.

SLEEPERS OR CROSS-TIES, &c.

78. The sleepers or cross-ties must be of approved sound timber, smoothly hewn, free from all score hacks, and chopped or sawn square at the ends, 8 feet long, flatted on two opposite sides to a uniform thickness of 6 inches, the flatted surface being not less than 6 inches, on either side, on the small end. They must be placed, as nearly as possible at uniform distances apart, and at right angles to the rails, in such a manner that about twenty-five per cent. of the length of the rail shall have a bearing upon the surface of the sleepers. "Joint sleepers" must have both an upper and under surface bearing, at their smallest end, of at least 8 inches.

79. When the sleepers are provided under a separate contract from the track-laying and ballasting, the Contractor for the latter shall take delivery of them, in the position and at the points in which they are received by the Government Inspectors.

80. The Contractors shall lay all sidings and put in all points and crossings complete, embracing wing and jack rails, head-blocks, switch and signal-frames, and gearing, and they shall remove from the track and straighten all bent and damaged rails, and make good all injuries done before the works are finally accepted, and further they will be held responsible for all materials provided them, and give a receipt for the same upon taking delivery. Track laying shall include the supplying, furnishing and laying plank, including spike for the same, on public and private road crossings, distributing rails, rail fastenings, spikes, points and crossings, ties, laying the same on main track and sidings, and centreing, lining and surfacing. Track-laying will be paid for by the lineal mile of 5,280 feet.

BALLASTING, &c.

81. The land for ballast pits and approaches thereto will be furnished by the Government and approved by the Engineer; in selecting land for the purpose, a preference will always be given to those points where the best material can be procured, having due regard to the convenience of the Contractors. During the working of any pit, should the material be found unfit for ballasting, the engineer shall have power to compel the contractors to close such pit and open others.

82. The surface of ballast pits shall be stripped of soil where such exists, and no material whatever shall be placed on the road bed but good clean gravel, free from earth, clay, loam, or loamy sand; no larger stones shall be allowed. The maximum size of gravel must not be greater in diameter than 3 inches. In unloading the ballast, the train must be kept in constant motion, working to and fro so as to thoroughly mix the different qualities of ballast, until a sufficient quantity is deposited for the first "lift." The track must then be raised so that there will be an average

depth of 6 inches beneath the sleepers, and the ballast must be well beaten and packed under and around them. As the raising proceeds the end of the lift shall extend over not less than three rail lengths; and, before trains are allowed to pass over the inclined portion of track, it must be made sufficiently solid to prevent bending the rails, or twisting the rail-joints. After the lift, the track shall be centred, lined, topped, surfaced and trimmed off to a proper form and width.

83. In the event of full ballasting being required, a second " lift" must be made, in the same manner and with the same precautions as required for the first " lift," in order to secure a uniform thickness of 12 inches under the sleepers.

84. In wet cuttings the Engineer shall have power to direct a greater thickness of ballast, should it be deemed necessary.

85. The Contractors shall keep all public and private road crossings in a safe and serviceable condition during the progress of the work, leaving them well and properly planked inside and outside of the rails, as may be directed by the Engineer, and gravelled to a depth of at least 10 inches for a distance of 50 feet on both sides of the track.

86. The track shall be left by the Contractors with everything complete, and well surfaced. The ballast shall be dressed off to the form required, and the whole shall be executed according to the direction and to the approval of the Chief Engineer, or other officer duly appointed.

87. The Contractors shall be paid by the cubic yard for all ballast put into track, the measurement to be made in the pit or excavation, and the price per cubic yard to cover the cost of lying tracks to the pit, stripping the ground, excavating, handling, hauling, putting the ballast on the road bed, and neatly trimming it off to the proper form.

MISCELLANEOUS WORK.

88. If any work or service be required to be done, which in the opinion of the Engineer does not come within the class of work to be measured under the contract, he shall be at liberty to direct the Contractor to perform the same by day's labour, and the Contractor when required by him shall supply such force as the Engineer may direct, and the Contractor shall perform such work, and he shall be paid the reasonable and actual wages of such force as ascertained by time-keeper and pay-sheet, together with fifteen per cent. for the use of tools and profit. The Engineer shall be at liberty to discharge any bad or unsuitable workmen who may be placed at day's labour work, and the work so performed shall be subject to his approval before payment thereof.

CONDITIONS OF CONTRACT.

The following are the Conditions under which the Contracts are entered into:

89. At any time before the commencement or during the construction of any portion of the work, the Engineer, under the authority of the Minister of Public Works, will be at perfect liberty to make any changes or alterations which he may deem expedient, in the grades, the line of location, the width of cuttings of fillings, the dimensions or character of structures, or in any other thing connected with the works, whether or not such changes increase or diminish the quantities of work to be done. The Contractor will be paid for the work actually executed by him, under the Engineer's directions and to his satisfaction, at the prices stipulated in the Contract, but he will not be entitled to any additional allowance by reason of any changes or alterations referred to.

90. Should any work, material, or thing of any description whatsoever be omitted from the Specification or Contract, which in the opinion of the Engineer is necessary or expedient to be executed, the Contractor shall, notwithstanding said omission, upon receiving written directions from the Engineer, perform the same, and the payment therefor shall be at the price for such work given in the schedule of prices; or if no price be given therefor, at such price as the Engineer may consider just and reasonable.

91. It is intended that every allowance to which the Contractor is fairly entitled, will be embraced in the Engineer's monthly certificates; but should the Contractor at any time have claims of any description which he considers are not included in the progress certificates, it will be necessary for him to make and repeat such claims in writing to the Engineer within fourteen days after the date of each and every certificate in which he alleges such claims to have been omitted.

92. The Contractor in presenting claims of the kind referred to, must accompany them with satisfactory evidence of their accuracy, and the reason why he thinks they should be allowed him. Unless claims are thus made during the progress of the work, within fourteen days, as in the preceding clause, and repeated, in writing, every month, until finally adjusted, it must be clearly understood that they shall be forever shut out.

93. Cash payments will be made every month on the certificate of the Engineer, equal to about 90 per cent. of the value of the work done, approximately made up from returns of progress measurements and computed at the prices stipulated in the contract. On the completion of the work, to the satisfaction of the Engineer, the quantities will be carefully made up from exact final measurement, and a certificate will be given thereon, but a final and closing certificate, including the ten per cent. retained, will not be granted for a period of at least two months thereafter.

94. The progress measurements and progress certificates shall not in any respect be taken as an acceptance of the work or release of the Contractor from his responsibility in respect thereof, but he shall at the conclusion of the work deliver over the same in good order, according to the true intent and meaning of the contract and specification.

95. The Contractor shall respect and preserve in their true and original position, all bench marks, hubs, all centre, slope, reference and all other stakes and marks placed or made by the Engineer, on or near the line of work; he shall adopt every means in his power to prevent their being burnt in the clearing, or altered, removed or destroyed at any time; and whenever required by the Engineer, he shall furnish the necessary assistance to correct or replace any stake or mark which through any cause may have been removed or destroyed.

95. The Contractor shall employ as many competent agents and foremen on the whole works as may be considered requisite by the Engineer; and the said foremen shall be regularly and constantly present on the works for the purpose of effectually overseeing the same, and of receiving instructions from the Engineer.

97. The Engineer shall have full power to dismiss any foreman or workman whom he may deem unfit for the duties assigned him, or who may, in the opinion of the Engineer, be guilty of slighting the work, or of wilful disobedience of orders, or of improper, intemperate or disorderly conduct; and the Contractor shall supply the places of all such men so dismissed, without delay, and he shall not employ them again on the works.

98. The Contractor is bound by the general conditions of the specification to provide all proper tools and plant for the execution of the work, and is responsible for the sufficiency of the same; he must also take upon himself the entire responsibility of the centreing, scaffolding, and all other means used for the fulfilment of the contract, whether such means may or may not be approved of or recommended by the Engineer; and the Contractor must run all risks of accidents or damages from whatsoever cause they may arise until the completion of the contract.

99. The Contractor shall, subject to the approval of the Engineer as to the same but at his own cost, make all necessary temporary provision during the progress of

the works for land owners crossing the line of railway, and he shall provide the necessary accommodation for the passage of the public at the intersection of public roads. He shall also, at his own cost, make such provision until the fences be erected, as may be necessary to prevent the straying of cattle where the fields in settlements are entered upon.

100. The Contractor shall be responsible for all damages to land owners arising from loss of crops, or cattle, or injury thereto, respectively sustained by any cause or thing connected with the construction of the work, or through any of his agents or workmen, and he shall be held responsible for all damages which may be done to property or persons through the blasting of rocks or other operations carried on by him, and he must assume all risks and contingencies, whether from fire, water, or any other cause whatever, that may arise during the progress of the works, and he must make good, at his own cost, all defects and failures, whether from negligence on the part of himself or workmen, or from bad workmanship, or from the use of improper materials, and he shall hold harmless and indemnify Her Majesty of and from any claims, losses or damages in respect thereof.

101. The Contractor shall not permit, allow, or encourage the sale of any spirituous liquors on or near the line of railway.

102. No work whatever shall at any time or place be carried on during the Sunday, and the Contractor shall take all necessary steps for preventing any foreman or agent or men from working or employing others on that day.

103. The Contractor shall by himself, his agents and workmen faithfully carry on the works until completion, and no sub-contract, assignment, or transfer shall in any way be recognized.

104. In the event of any bad material being delivered or any bad work being executed at any time, the same shall be immediately removed on notice being given by the Engineer, and the work shall be reconstructed in strict conformity with the true meaning of the specification and to the entire satisfaction of the Engineer.

105. The Minister of Public Works reserves the right to suspend, without notice in advance, operations at any particular point or points, and in the event of such right being exercised so as to cause any delay to the contractor, then an extension of time equal to such delay or detention shall be allowed him to complete the contract, but any such delay shall not entitle the Contractor to any claim for damages.

106. If at any time during the progress of the works, it should appear to the Engineer that the force employed, or the rate of progress then being made, or the general character of the work being performed, or the materials supplied or furnished are not respectively such as to ensure the completion of the said works within the time stipulated, or in accordance with the contract, the Minister of Public Works shall be at liberty to take any part or the whole works out of the hands of the Contractor, and employ such means as he may see fit to complete the works at the Contractor's expense, and he shall be liable for all extra expenditure incurred thereby; or the Minister of Public Works shall have power, if it may be deemed advisable, to nullify the contract.

107. Should the Contractor become insolvent or bankrupt, or so embarrassed in circumstances, as to be unable in the opinion of the Minister of Public Works properly to proceed under the contract, the Minister of Public Works shall be at liberty to nullify the contract.

108. Should the Contractor pursue any course violating any of the provisions of the contract, or the evident import of the same, the Minister of Public Works shall have power to nullify the contract.

109. Whenever it may become necessary to take any portion or the whole work out of the hands of the Contractor, or to nullify the contract, the Minister of Public Works shall give the Contractor seven days clear notice in writing of his intention, such notice being signed by the Secretary of the Department of Public Works, and the Contractor shall thereupon give up quiet and peaceable possession of the works as they then exist, as well as material or plant which he may have been furnishing or using; and without any other or farther notice or process or suit at law, or other legal proceedings of any kind whatever, the Minister of Public Works, in the event of his

nullifying the contract, may forthwith or at his discretion, proceed to relet the same, or any part thereof, or employ additional workmen, tools and materials, as the case may be, and complete the work as may be deemed best. In the event of the contract being nullified through any neglect or fault of the Contractor, the work shall be completed at his own expense and he shall be liable for all extra expenditure which may be incurred thereby, and the Contractor and his assigns or creditors, shall forfeit all right to the percentage retained and to all money which may be due on the works, and to the deposit stipulated for in the 115th clause, and he shall not molest or hinder the men, agents or officers of the Minister of Public Works or the new Contractor, from entering upon and completing the said work as the Minister of Public Works may deem expedient.

110. Any notice or other matter under or connected with the contract may be served on the Contractor either at his usual domicile or at an address to be mentioned in the Contract, or attached to the signature of the Contractor thereto, or at his last known place of business, by being left at any Post Office in Canada, and shall be deemed to be thereby legally served.

111. If at any time it shall appear to the Engineer that the security of the works is endangered, or the peace of the neighbourhood is likely to be disturbed, or any other difficulty likely to arise by reason of the men being left unpaid, the Government may pay any arrears of wages so far as they may ascertain the same to be due on the best information they may obtain, and charge the same as a payment on account of the contract.

112. The Contractor shall perform and execute all works required to be performed under the contract in a good, faithful, substantial, and workmanlike manner, and in strict accordance with the plans and specifications thereof and with such instructions as may be from time to time given by the Engineer, and shall be under the direction and constant supervision of such District, Division, and Assistant Engineers and Inspectors as may be appointed. All the works are to be executed and material supplied to the Engineer's entire satisfaction. Should any difference arise as to the meaning of the specification, conditions, or plans, or contract, or as to anything arising out of any of them, or done or omitted to be done under any of them, or as to any rights of any of the parties under any of them, the same is to be decided by the Engineer, who is to be the sole judge thereof, and whose decision thereon is to be final and binding on all parties, and is not to be subject to any appeal or petition or legal adjudication of any kind. The powers of the Engineer above given, extend to all questions as to the meaning of the specification, conditions, plans or contract, or as to points not provided for or not sufficiently explained in any of them, or as to the quantity or quality of work or material, or as to the right of the Contractor to any monies, but this enumeration of some of the powers of the Engineer is not to be read as having the effect of in any wise limiting or contracting the powers conferred upon him by the general language of this clause.

113. The term "Engineer" made use of in the specification and contract, means "The Engineer in Chief," or some one of his assistants acting under his authority and instructions, and all instructions or directions, judgments or decisions given, or powers exercised by any one acting for the Engineer in Chief or under his authority will be subject to his approval.

114. No tender will be entertained unless on one of the printed forms prepared for the purpose, and with the schedule of quantities therein correctly priced and accurately moneyed out; nor unless an accepted bank cheque, or other available security of *one thousand dollars* accompanies the tender, which shall be forfeited if the party tendering declines or fails to enter into contract for the works, when called upon to do so, at the rates stated in the offer submitted. In the event of a tender not being accepted, the cheque or other security will be returned.

115. For the due fulfilment of the contract satisfactory security will be required by deposit of money, public or municipal securities, or bank stock, to the amount of about five per cent. on the bulk sum of the contract, to which the sum sent in with the tender will be considered a part.

116. To each tender must be attached the usual signatures of two responsible and solvent persons, residents of the Dominion, willing to become sureties for the carrying out of these conditions, as well as the due performance of the works embraced in the contract.

117. The works are to be commenced as soon as practicable after the person or persons whose "Tender" may be accepted shall have entered into contract, and must be proceeded with in such a manner as to secure their completion at the date named in the "Bill of Works" for each contract.

SANDFORD FLEMING,

Engineer in Chief.

Canadian Pacific Railway Office,

Department of Public Works,

Ottawa, April 18th, 1876.

INDEX.

A

B

C

D

E

G

H

Page

N

O

P

Q

R

T